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Proposed regulatory standards for
new landfilling sites ...

BACKGROUND

PROPOSED REGULATORY

STANDARDS FOR NEW

LANDFILLING SITES ACCEPTING

NON-HAZARDOUS WASTE



Ontario

JUNE 1996

WASTE REDUCTION BRANCH

MINISTRY OF ENVIRONMENT AND ENERGY



PREFACE

Requirements for the design and operation of landfilling sites are defined in Ontario Regulation 347 under Part V of the Environmental Protection Act. The current regulatory requirements identify general areas of environmental concern which must be addressed before the Ministry of Environment & Energy issues a certificate of approval for a site. Specific details of any potential environmental impacts (eg. on groundwater or surface water) and how they can be addressed are dealt with on a site specific basis in the process of obtaining the certificate of approval.

The absence of specific regulatory standards has been cited as adding uncertainty and delay to the approvals process. By introducing clear, strong landfill standards as proposed in this paper a more efficient and effective approvals process will result. These new standards will also ensure that new landfills in Ontario are second to none in protecting the environment.

The changes proposed in this paper are the result of work carried out by the Ministry with technical advice provided by a consulting team led by M.M. Dillon Limited.

This paper is being released as part of a 30 day public consultation program by the Ministry. Interested individuals and groups are invited to comment on the proposed standards by making written submissions to the Ministry's Waste Reduction Branch. Comments should be sent by July 19, 1996.

Send your comments to:

New Standards For Landfilling Sites
Waste Reduction Branch
Ministry of Environment & Energy
40 St. Clair Ave. West, 7th Floor
Toronto, Ontario M4V 1M2

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PROPOSED STANDARDS FOR NEW AND EXPANDED LANDFILLING SITES ACCEPTING NON-HAZARDOUS WASTE

INTRODUCTION AND PURPOSE

This paper includes proposals for new detailed landfill standards which will ensure that new landfills in Ontario are second to none in the protection they provide to the environment. By making current requirements more explicit and introducing standards in new areas, the new standards will bring clarity and certainty to the landfill approvals process.

The absence of detailed regulatory standards has been cited by many as adding uncertainty and delay to the approvals process. Existing requirements for the design and operation of landfills are contained in Ontario Regulation 347. Regulation 347 is the general waste management regulation under Part V of the Environmental Protection Act. Although the current regulation identifies general areas of environmental concern, the specific issues and requirements to be addressed are dealt with on a site specific basis during the approvals process. The proposed new standards are intended to remove the uncertainty in the current process and decrease the time and cost of establishing the necessary landfill capacity. The new standards build upon the experience gained with the existing process by codifying many existing approval requirements. In other areas, new or more explicit requirements are proposed.

An efficient and effective waste management program requires that an integrated approach to waste management be taken. Although the Ministry of Environment & Energy continues to emphasize the 3Rs (Reduce, Reuse and Recycle), landfilling is necessary to manage the residuals of 3Rs processing and wastes which are not amenable to reuse or recycling. Even with the availability of incinerators as a disposal option, landfilling remains as a necessary part of waste management, whether to manage incinerator ash or as a preferred disposal option.

The Ministry is interested in receiving comments on the proposed new standards from municipalities, the private sector, environmental or community groups, and any other interested persons. Comments from both those who may be affected by a nearby landfill and those who are responsible for obtaining new landfill capacity are important. All comments will be considered by the Ministry when finalizing the standards.

WHO IS AFFECTED?

The new standards apply to landfilling sites which accept non-hazardous waste whether the site is owned by a municipality or a private landfill operator. The standards apply to all new landfilling sites and to the expansion of existing sites. The new standards do not apply to small landfills or existing sites which are not being expanded. For purposes of the standards, a small landfill is considered to be a site with a total waste disposal volume of 40,000 cubic metres or less. This size of site would serve a municipality with a population of 1500 persons for approximately 20 years. For these other sites, the existing landfilling site requirements currently practised under the Environmental Protection Act and Regulation 347 will remain in effect.

Some of the proposed standards apply only in certain circumstances. For example, the proposal for collection of air emissions from landfills only applies to relatively large sites (ie. 3.5 million cubic metres or more). In other cases, the specific standards may be inappropriate. For example, sites located in heavy, non-permeable clay can effectively be designed and operated without the engineered liner requirements. Flexibility is built into the requirements to allow local solutions to develop provided there continues to be full health and environmental protection.

SUMMARY OF THE STANDARDS

The new standards described in this paper include requirements for location, design, operation and closure of sites. The standards apply to all new or expanded landfilling sites (except small sites) accepting non-hazardous waste. The standards cover issues such as:

- location restrictions in the area of public airports, hazardous lands (eg. floodplains) and natural heritage features (eg. significant wetlands),
- requirements for the assessment of hydrogeologic and surface water conditions,
- design specifications including:
 - design criteria for site specific design, and
 - two generic design options,
- a contingency plan for leachate management,

- minimum operating and monitoring requirements,
- mandatory air emissions control for sites with total capacities greater than 3.5 million cubic metres,
- closure and post-closure care provisions, and
- financial assurance requirements for private sector facilities.

The new standards along with a rationale for these requirements are outlined below. A detailed listing of the proposed standards is provided in Appendix A.

Location

Public Airports

Landfilling sites are a potential hazard to aircraft operations because they can attract flocking birds such as gulls. In order to ensure landfills do not become a threat to aircraft, care should be exercised in the location of landfills. Combined with good operating procedures and a bird control program, any concerns with flight safety should be minimal. The new standards require a bird hazard study be carried out for any new site to be located within 8 kilometres of a public airport.

Hazardous Lands

New landfilling sites should not be located within floodplains or areas prone to excessive erosion. The building of landfills in these areas unnecessarily increases the risk of damage to the landfill and the release of contaminants to waterways and the environment. The restriction on locating sites within these areas is consistent with the recent Provincial Policy Statement made under the Land Use Planning and Protection Act.

Natural Heritage Features

Landfilling sites should not be located in environmentally sensitive areas. Significant habitat of endangered and threatened species, significant wetlands and areas of natural and scientific interest should be protected. The proposed standard applies to the natural feature and a surrounding 500 metre buffer zone. The areas identified here are consistent with the recent Provincial Policy Statement made under the Land Use Planning and Protection Act.

Site Assessment and Design

Hydrogeology and Surface Water

An evaluation of the hydrogeologic setting and surface water features in the vicinity of a landfilling site is an important part of determining the suitability, design and monitoring requirements for a site. The landfill standards require that these evaluations be carried out and provide direction on the expected content of the studies. Requirements include a description of regional conditions within 5 kilometres of the site, a detailed study of site conditions, and a geotechnical assessment of the site. For the detailed site study, the standards include provisions such as:

- the drilling of a borehole to a minimum 30 metre depth or bedrock to confirm the regional hydrogeology,
- the drilling of boreholes to characterize the soil to a minimum 10 metre depth below the landfill base or bedrock to characterize site hydrogeology,
- the preparation of plans and descriptions of the surface water courses, water table elevations and groundwater flow patterns, and existing water uses, and
- the analysis of background groundwater and surface water quality for more than 30 contaminants.

Design Specifications

Landfilling sites must be well designed for groundwater and surface water protection, to ensure impacts from site operation are minimized and to facilitate site closure and post-closure care. The design standards are intended to reach a balance between regulatory certainty and the need for site specific design flexibility. The standards require the landfill owner to prepare a detailed site plan and specify, where necessary, design features including:

- site boundaries, buffer zone, waste fill area and contours, on-site roads and structures, and final cover design,
- liner and leachate collection system design,
- control facilities for surface water and landfill gas,
- monitoring facilities for groundwater, leachate, surface water and landfill gas,
- contingency plan concept, and

- site end-use plan.

The design standards also include specific provisions dealing with quality assurance and control, final slope specifications, and design criteria for noise. To ensure the design of the final cover is consistent with the infiltration requirements for groundwater protection, a specific final cover design (ie. minimum permeability) has not been prescribed in the standards. Confirmation that the site has been constructed as designed is addressed by the requirement for completion of a site preparation report prior to the commencement of landfilling operations.

Design Criteria For Groundwater Protection

Groundwater protection is fundamental to good landfill design. Groundwater is often the primary source of rural and urban water supply, and may be a significant component of streamflow. Preventing groundwater contamination is particularly important because of the difficulty and cost of restoration. Once contaminated, it often takes many years to clean-up groundwater.

To protect groundwater resources, landfills must currently be designed to meet stringent contaminant limits in accordance with the Ministry's existing Reasonable Use Guideline. The Reasonable Use Guideline establishes limits for the discharge of contaminants based on existing groundwater quality and the reasonable use of groundwater on adjacent property. The discharge limit is set at the property boundary and at a level which is considered to have only a "trivial" effect on the use of groundwater. As the reasonable use of groundwater is often drinking water, the quality of groundwater may not be degraded by an amount in excess of:

- 50% of the difference between background and the Ontario Drinking Water Objectives for non-health related parameters (eg. chloride), or
- 25% of the difference between background and the Ontario Drinking Water Objectives for health related parameters (eg. lead).

In some cases, however, the Reasonable Use Guideline allows alternative discharge limits. For example, where poor quality or limited supply indicates the reasonable use of groundwater is not drinking water, less stringent discharge limits may be set. These alternative limits would be defined by the Ministry on a case-by-case basis.

The requirements of the Reasonable Use Guideline are included in the new landfill standards. The standard for groundwater protection incorporates the Reasonable Use approach directly in a site specific design option and indirectly in a generic design option.

The site specific design option provides the site owner with flexibility to design the site to suit the local environmental setting provided the Reasonable Use limits for the site can be

met. To provide more certainty for this option, the standards also specify design criteria to be used in site assessment, including:

- the chemical parameters to be modelled,
- waste and leachate characteristics for listed chemical parameters,
- decay constants (ie. half-lives) for the listed organic parameters, and
- the design life of liners and leachate collection systems.

The design criteria specified in the new standards are considered to be very protective and are appropriate for the design of non-hazardous waste landfills.

The standards also include a generic design approach with two generic design options which specify particular designs for the liner and leachate collection systems. The generic designs have been developed such that the Reasonable Use limits for impact on groundwater would be met immediately below the liner system rather than at the property boundary for the landfill. Requiring compliance below the liner system is more protective than the normal Reasonable Use requirement for compliance at the property boundary. Any additional benefit due to contaminant reduction or attenuation at the site (for example, due to the presence of additional silty or clayey soils) is not accounted for when using the generic designs. The generic designs are very protective and would not likely be required if the site specific design approach is followed. The advantage of the generic designs is the added certainty that the design will adequately protect the groundwater environment.

The two generic design options differ with respect to their level of engineering and the maximum quantity of waste which they can handle. The larger design option would allow a greater quantity of waste to be deposited at a particular site but the level, and cost, of engineering would be higher. Although either generic design option could be selected, it is likely that the larger design option would be selected to accommodate a larger site. The choice between the two generic designs, however, would depend on the particular circumstances of each situation.

A conceptual view of a landfill incorporating the generic design approach is shown in Figure 1. The major components of the two generic design options are shown in Figures 2 and 3, and are summarized as follows:

1. Small/Medium Sized Site

This generic design (shown in Figure 2) may be used where no more than **90,000 cubic metres per hectare** of waste disposal volume is to be used and provided the

FIGURE 1
GENERIC DESIGN APPROACH

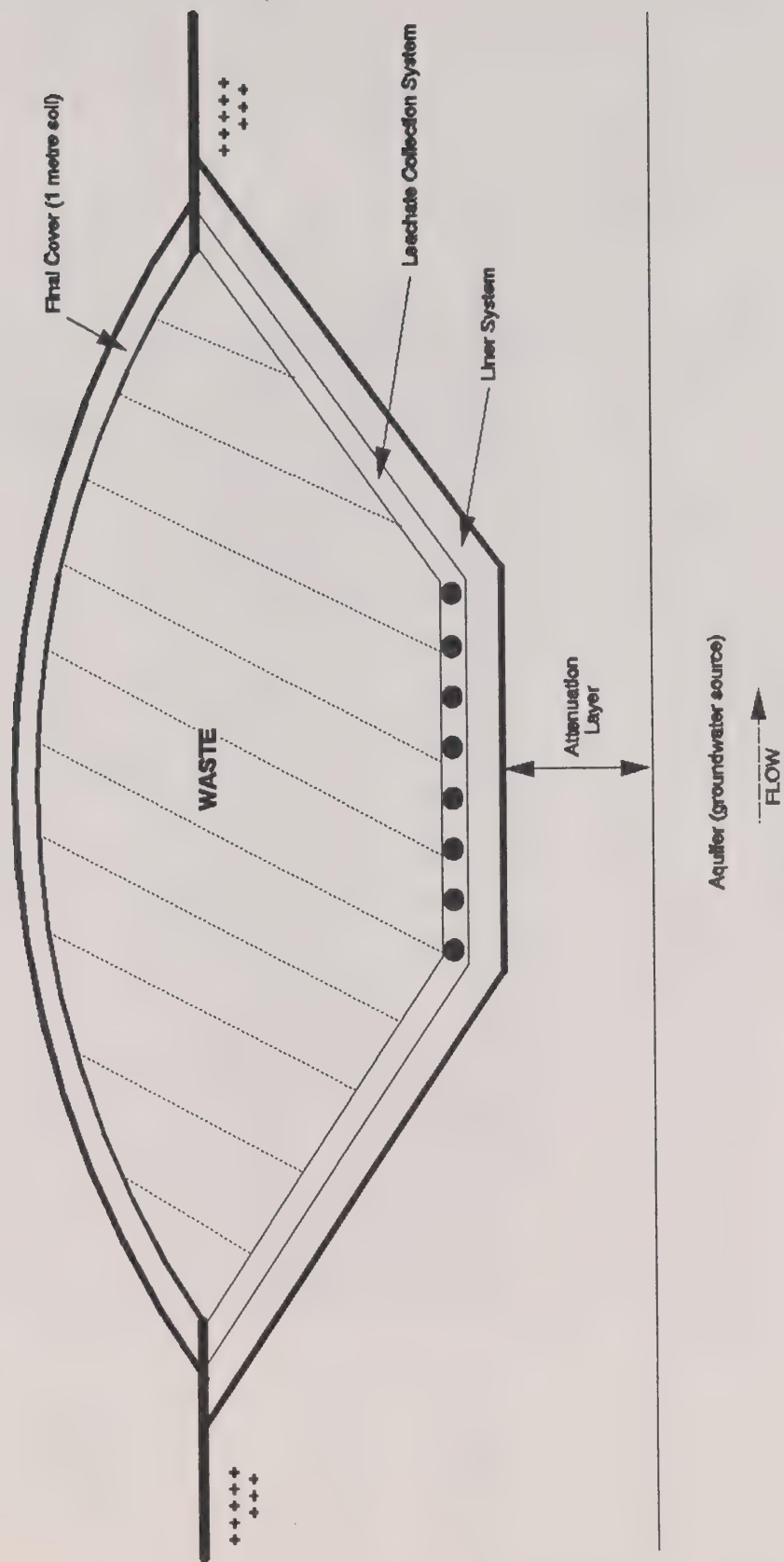


FIGURE 2

GENERIC DESIGN

Liner/Leachate Collection System for
Small/Medium Sized Site

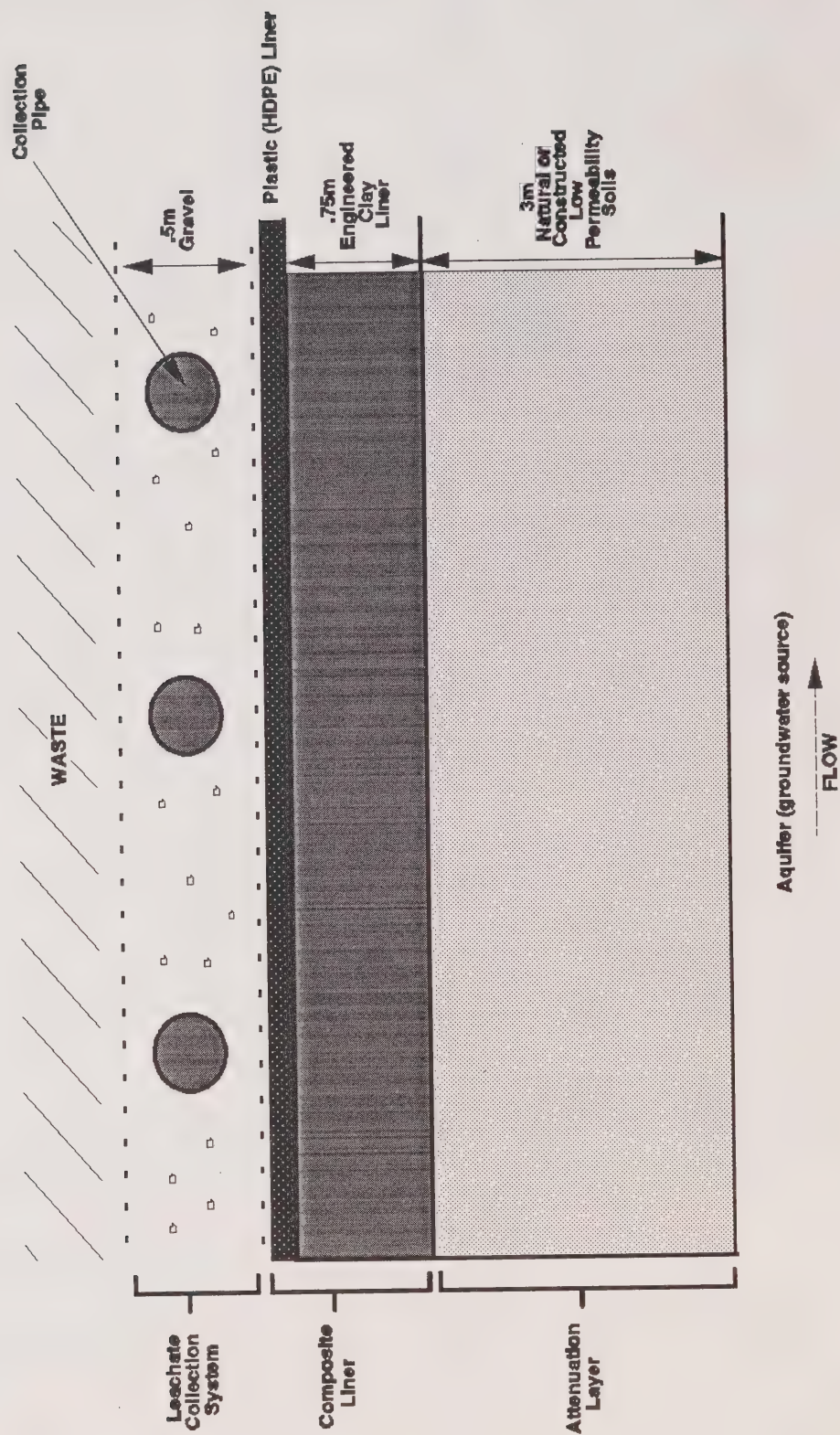
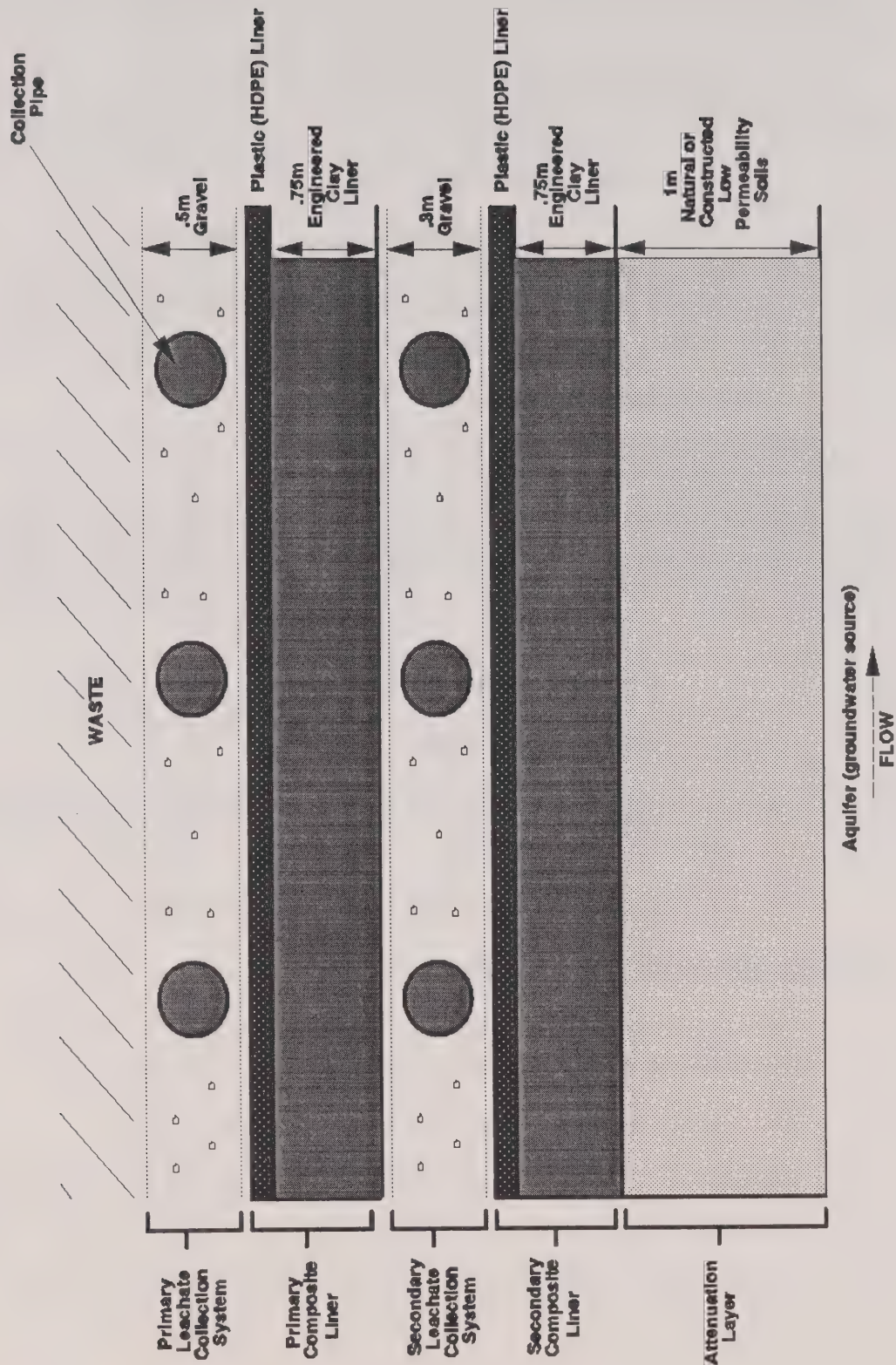


FIGURE 3

GENERIC DESIGN

Liner/Leachate Collection System for
Large Sized Site



background chloride concentration in the groundwater aquifer to be protected is no more than **50 mg/L**:

- a. A single **composite liner** consisting of,
 - a 2 millimetre (80 mil) thick high density polyethylene (HDPE) geomembrane liner, and
 - a 0.75 metre thick clay liner below the HDPE liner.
- b. A natural or constructed 3 metre thick **attenuation layer** below the composite liner.
- c. A **leachate collection system** above the composite liner.

2. Large Sized Site

This generic design (shown in Figure 3) may be used where no more than **250,000 cubic metres per hectare** of waste disposal volume is to be used and provided the background chloride concentration in the groundwater aquifer to be protected is no more than **50 mg/L**:

- a. Two **composite liners** consisting of:

Primary (Upper) Composite Liner

- a 2 millimetre (80 mil) thick high density polyethylene (HDPE) geomembrane liner, and
- a 0.75 metre thick clay liner below the HDPE liner;

Secondary (Lower) Composite Liner

- a 2 millimetre (80 mil) thick high density polyethylene (HDPE) geomembrane liner, and
 - a 0.75 metre thick clay liner below the HDPE liner;
- b. A natural or constructed 1 metre thick **attenuation layer** below the lower composite liner; and
 - c. **Two leachate collection systems** with the first located above the upper composite liner, and the second located between the upper and lower composite liners.

The generic designs were developed using contaminant transport modelling. A basic liner and leachate collection system was selected and the modelling run to assess performance of the system relative to Reasonable Use limits. The modelling was performed using the computer program POLLUTE (© Rowe et al., 1994). Input parameters (eg. waste and leachate characteristics) used in the modelling were the same as those referred to above for the site specific design approach.

Landfill Gas

The natural biodegradation of organic waste in a landfill produces a gas that is either emitted to the atmosphere through the cover or migrates in the soil below ground surface. The major constituents of landfill gas are methane and carbon dioxide. Small amounts of other compounds may also be present in landfill gas.

The methane component of landfill gas is a potential energy source but also poses an explosion hazard if it becomes trapped in enclosed spaces at levels ranging from 5 to 15 percent by volume. Methane gas, and to a lesser extent carbon dioxide, are "greenhouse" gases which contribute to global warming. The trace components of landfill gas such as hydrogen sulphide, mercaptans and non-methane organic compounds may create nuisance odours and degrade air quality.

The new landfill standards address both the sub-surface migration of landfill gas as well as air emissions. The standards require an assessment of the potential generation and migration of landfill gas, and set limits for control.

Sub-surface migration is addressed by specifying maximum levels of methane permitted to migrate off-site and accumulate in buildings at the site. The limits specified in the standards for sub-surface migration are:

- less than 5 percent methane gas at the property boundary,
- less than 1 percent methane in, or in the foundation of, an on-site building, and
- methane from the site should not be present in, or in the foundation of, a building located off-site.

For emissions to air, the standards require mandatory collection of landfill gas for new or expanded sites with a total waste disposal volume greater than 3.5 million cubic metres. This volume equates to approximately 2.5 million tonnes of waste. Where a site of this size will not receive significant quantities of organic waste, gas collection may not be required.

Operation and Monitoring

Operation and Maintenance Procedures

Good operation and maintenance procedures must be implemented at a landfilling site to ensure environmental control works continue to function as designed and for as long as they are needed. Operation and maintenance procedures are also important in minimizing potential nuisance impacts such as noise, odour and dust. The new landfill standards require that the landfill owner specify the procedures to be followed at a particular site. The standards identify the issues to be addressed in the operations plan and give direction on acceptable procedures for some activities. The operations plan for a site covers activities including:

- a waste control program to identify unacceptable wastes and ensure regulated hazardous wastes are not accepted,
- site supervision and security,
- cover material type, source and stockpiling,
- operation and maintenance procedures for environmental control and monitoring facilities,
- procedures to control noise, odour and dust,
- any procedures, such as enhanced water infiltration, intended to shorten or otherwise alter the contaminating life span of the site, and
- a complaint response plan to address public concerns with site operations.

The new standards provide specific direction on requirements such as daily and intermediate cover, record keeping and monitoring. Continuing opportunities for public involvement and specific requirements for leachate, groundwater and surface water monitoring are also included.

Groundwater and Surface Water Monitoring

Regular monitoring of groundwater and surface water is necessary to demonstrate that a landfilling site is performing as designed and to identify any potential problems. The new landfill standards define the parameters and the frequency of monitoring. Monitoring of the quantity and quality of leachate produced within the site itself is also required. The locations for monitoring would be determined on a site specific basis.

The **groundwater and leachate** monitoring program includes the following:

- annual monitoring for a comprehensive list of inorganic and organic parameters including metals and volatile organics,
- quarterly monitoring for a reduced list of indicator parameters,
- monthly measurements of leachate mounding within the waste and continuous monitoring of leachate quantities removed from the site, and
- where requested by nearby property owners, annual monitoring of domestic wells.

The **surface water** monitoring program includes the following:

- semi-annual monitoring for a comprehensive list of inorganic and organic parameters including metals and volatile organics, and characteristics such as flow, temperature and dissolved oxygen,
- quarterly monitoring for a reduced list of indicator parameters, and
- annual monitoring of biological features (ie. benthic, or bottom dwelling, organisms such as flies and worms).

An assessment of the monitoring results relative to the expected impacts must be carried out by the site owner and included along with the monitoring results in an annual site monitoring report.

Public Liaison Committee

The opportunity for continuing public input in the activities taking place at a landfilling site is a requirement of the proposed new standards. Questions and comments from the public and local representatives are important to helping maintain a commitment to high standards of operation and environmental protection at a site. The new standards require that the landfill owner form a public liaison committee and host meetings regularly during the year. The invitation to participate on the public liaison committee is to be extended to nearby residents, and the local and upper tier municipalities. Copies of the annual operations report for the site and any submissions to the Ministry are to be provided to the liaison committee. The specific terms of reference for the operation and involvement of the committee beyond the requirements of the standards would be determined on a site specific basis.

Annual Report

The proposed standards require the site owner to prepare an annual report that documents the results of site impact monitoring, the current status of site development and capacity usage, upcoming phases of site development and any operational concerns. Based on the annual report and the day-to-day reviewing of site activities, recommendations for possible improvements to site design or operations are to be identified in the annual report. For private sector landfills, the standards also require that an update of the financial assurance estimate for the site be provided. An annual report summarizing site operations during the previous year is an important tool in monitoring site activities and environmental compliance. Preparation of an annual report also reinforces the need for continual improvement in site operations.

Closure and Post-Closure Care

Once a landfilling site has stopped receiving waste, it must be closed in a manner which ensures the long term protection of the environment and is aesthetically acceptable. Site closure activities involve the progressive closure of portions of the fill area as they reach final approved contours. While the closure of some smaller sites may only require the application of final cover and limited post-closure monitoring and maintenance, larger sites likely require significant ongoing care including the operation and maintenance of leachate and gas control systems.

The post-closure period (or contaminating life span) for a landfill depends on the environmental setting, the level of engineering, and the expected service life of the engineered works. The post-closure period may extend from many decades to several hundreds of years. The duration of the post-closure period may also depend on the type of waste accepted and whether operational procedures such as enhanced infiltration have been practised to facilitate waste stabilization.

The proposed landfill standards require the landfill owner to prepare a report detailing site closure and post-closure care. The report is to be prepared at least two years before the expected date of closure or once 90 percent of the site has been filled. The report updates and provides more details on the closure and post-closure activities originally outlined in the design report for the site. Information to be included in the closure and post-closure care report includes:

- notification procedures of upcoming site closure,
- completion and ongoing maintenance of the final cover and landscaping,

- the planned end use for the site,
- final construction of any environmental control or monitoring facilities,
- ongoing operation and maintenance of any environmental control or monitoring facilities, and
- for private sector landfills, an update of financial assurance requirements.

To help ensure the site continues to perform as designed, the standards also require an annual post-closure report be prepared summarizing the results of site monitoring and continued operation and maintenance requirements for the environmental control works. Post-closure care will be required for as long as the site poses a potential concern to the environment.

Financial Assurance

Financial assurance is needed for private sector landfills to ensure funds are available to carry out any necessary monitoring or maintenance activities, and to correct potential environmental problems. Currently the Ministry requires financial assurance by imposing conditions on the certificate of approval for each private sector landfill. Financial assurance is normally provided as a cash deposit, letter of credit or bond. Financial assurance is not required for a site owned by a municipality.

Under the proposed landfill standards, the cost estimates for site closure and post-closure care are to be determined on a case-by-case basis. As there is considerable experience with these activities, reasonable estimates can be made for each landfill based on site design, the level of engineering and environmental setting. The new standards require that the closure and post-closure funding be accumulated during the operating life of the site, with all funding to be in place five years before closure or upon filling 80 percent of the site.

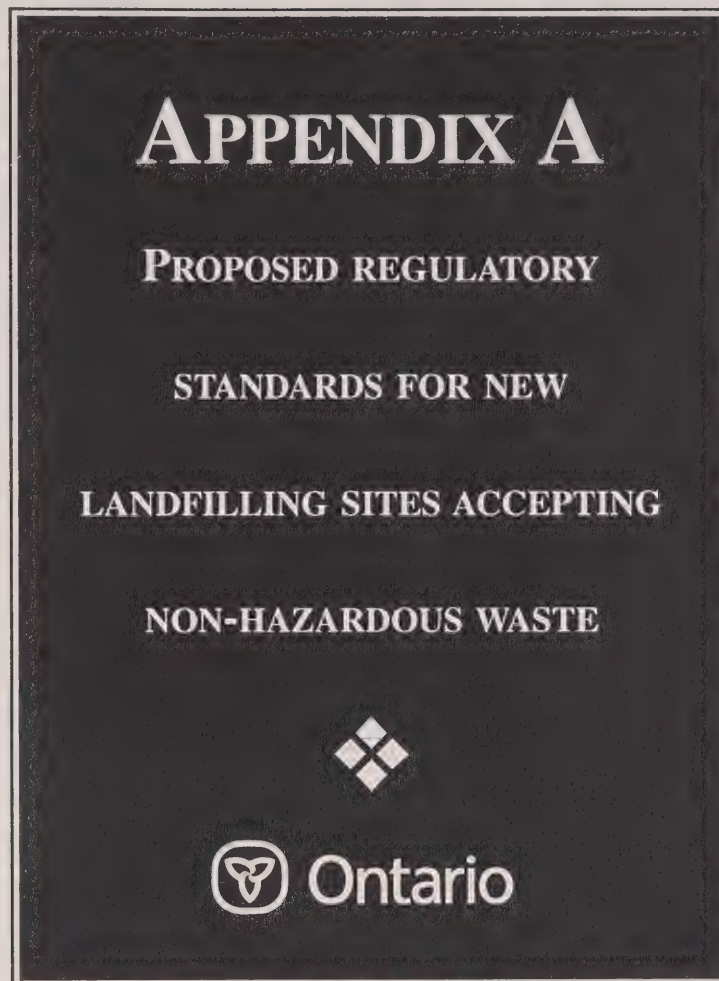
The landfill standards also require financial assurance be provided for the leachate contingency plan. Although it is not expected that the contingency plan would need to be implemented, some monies must be available in case environmental problems arise. To simplify the financial assurance requirements for contingency plans, the new standards propose that the amount be determined on a per tonne basis. Based on a review of contingency funds provided for existing sites, a fifty cents per tonne amount has been proposed in the landfill standards. The total amount of the contingency fund for a site would be determined by multiplying the fifty cents per tonne amount by the total tonnage capacity of the site. This amount would then be adjusted to account for the date when the site is actually to be closed. While being consistent from site to site, this approach still recognises that the amount of financial assurance should reflect the size of the landfill (ie. a larger site generates a larger fund). Funds for the contingency plan would be accumulated during the

operating life of the site, with all funding to be in place five years before closure or upon filling 80% of the site.

As an alternative to establishing separate contingency funds for each private sector landfill, the standards also include a clause allowing a single fund to be established for a group of sites. A group financial assurance plan can be viewed in a similar manner as insurance in the sense that they are for unexpected costs. The specific details of such a group plan would have to be acceptable to the Ministry.

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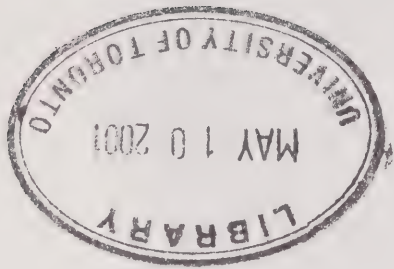
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PROPOSED NEW LANDFILL STANDARDS

The following are proposed standards for new or expanded non-hazardous waste landfilling sites with a total waste disposal volume of more than 40,000 m³:

Location

1. Public Airports

- (1) The site shall not be located within 8 km of the reference point(s) of a public airport unless a report prepared by the owner shows that locating the site within this zone would not pose a bird hazard to aircraft.
- (2) In addition to an assessment of the potential bird hazard, the report shall include the views of the owner of the airport and the airport regulator on the potential bird hazard posed by the proposed location of the site.

2. Hazardous Lands

- (1) The site shall not be located within an area identified by the Ministry of Natural Resources as:
 - a. defined portions of the dynamic beach;
 - b. defined portions of the one hundred year flood level along connecting channels (the St. Mary's, St. Clair, Detroit, Niagara and St. Lawrence Rivers); and
 - c. a floodway (except in those exceptional situations where a Special Policy Area allowing the landfill site has been approved).
- (2) The site shall not be located within an area identified by the Ministry of Natural Resources as:
 - a. hazardous lands adjacent to the shorelines of the Great Lakes - St. Lawrence River System and large inland lakes that are impacted by flooding, erosion, and/or dynamic beach hazards;
 - b. hazardous lands adjacent to river and stream systems that are impacted by flooding and/or erosion hazards; and
 - c. hazardous sites;

unless a report prepared by the owner shows that locating the site within this area would not create an unacceptable risk of damage to the site or of the release of contaminants from the site and, in the case of river and stream systems, would not reduce the capacity of the regulatory flood plain to contain or transmit flood water.

3. Natural Heritage Features and Areas

- (1) The site shall not be located within 500 m, or if greater, within the adjacent buffer lands identified by the Ministry of Natural Resources, of an area identified by the Ministry of Natural Resources as:
 - a. a significant habitat of endangered and threatened species; and
 - b. significant wetlands south and east of the Canadian Shield.
- (2) The site shall not be located within 500 m, or if greater, within the adjacent buffer lands identified by the Ministry of Natural Resources, of an area identified by the Ministry of Natural Resources as:
 - a. fish habitat;
 - b. significant wetlands in the Canadian Shield;
 - c. significant woodlands south and east of the Canadian Shield;
 - d. significant valleylands south and east of the Canadian Shield;
 - e. significant wildlife habitat; and
 - f. significant areas of natural and scientific interest;

unless a report prepared by the owner shows that locating the site within this area would not cause an adverse effect on the feature or area.

Site Assessment and Design

4. Hydrogeologic Assessment

Prior to the establishment or expansion of a site, a report shall be prepared by the owner containing plans, specifications, and descriptions of the hydrogeologic conditions of the site, adjacent and nearby properties, and the regional area in which the site is located, including, at a minimum, the following;

- a. a general description of the regional geologic and hydrogeologic conditions occurring within 5 km of the site. This description should identify any unstable soils or bedrock, indicate the location and nature of any boundaries to groundwater movement, and characterize the significance of groundwater resources and the use made of these resources;
- b. a description of the local hydrogeologic conditions occurring at the site, and adjacent and other properties within 500 m of the site, and the description shall indicate how local conditions relate to regional conditions;
- c. a detailed hydrogeologic investigation of the site which establishes soil, rock, and groundwater conditions, including:
 - i. the drilling, at a minimum, of a single borehole to a minimum depth of 30 m below ground surface or to bedrock and the logging and testing of this borehole, as necessary, to confirm the understanding of regional hydrogeology derived from the review of data undertaken for Subsection 4.a. above;
 - ii. the drilling of boreholes hydraulically upgradient and hydraulically downgradient of the potential waste fill area and in other locations, as necessary, to a depth and in a manner sufficient to:
 - provide soil samples of a number and type to adequately characterize the thickness and nature of soil units underlying the site to a depth of at least 10 m below the landfill base or to bedrock;
 - provide soil samples of a number and type for laboratory analysis of physical and/or chemical properties;
 - permit, as necessary, the geological and/or geophysical logging of the borehole;
 - permit installation, as necessary, of groundwater monitoring facilities; and
 - permit other tests of soil and/or borehole properties, as necessary.
 - iii. the use of drilling, coring, drive-points, test pitting, trenching, and/or other means of soil excavation/sample extraction to

obtain representative samples of soil and/or rock for the testing of soil and/or rock properties and chemistry/quality;

- iv. the installation in boreholes of groundwater monitoring facilities in a manner appropriate to the collection of groundwater samples or the measurement of groundwater levels or hydraulic pressures representative of the hydrostratigraphic units beneath the site;
- v. the development and purging of groundwater monitoring facilities, as necessary, in a manner and over a period of time sufficient to ensure that water level/hydraulic pressure data collected in the groundwater monitor and/or groundwater samples collected from the groundwater monitor are representative of hydrogeologic conditions beneath the site;
- vi. the collection, in a manner which ensures data are representative and are accurate to within ± 0.5 cm, of a sufficient number of measurements of groundwater level/hydraulic pressure in groundwater monitoring facilities to confirm, as necessary:
 - that the groundwater monitor is functioning properly; and
 - attainment of static water level;and to establish, as necessary,
 - differences in water level/hydraulic pressure both laterally and vertically beneath the site;
- vii. the collection of groundwater samples from groundwater monitoring facilities in a manner that ensures these samples are in a sufficient number and over a sufficient period of time to establish the potential seasonal and/or spatial/depth variability of groundwater chemistry/quality beneath the site (i.e., over at least a one year period);
- viii. the analysis of groundwater samples from groundwater monitoring facilities for the parameters listed in column 1 of Schedule 1; and
- ix. the use of pumping tests, slug tests, and other procedures, as necessary, to measure the in-situ permeability of soil units beneath the site;

- d. an interpretation of the results of the detailed hydrogeologic investigation of the site, including the following plans, specifications, and descriptions:
- i. a contour plan of the ground surface, showing surface watercourses and bodies of surface water, if any;
 - ii. a contour plan of the water table, showing expected directions of groundwater movement;
 - iii. piezometric contour plans for each aquifer, showing expected directions of groundwater movement;
 - iv. a description of the interconnection of aquifers, with generalized estimates of groundwater flow;
 - v. site plans and cross sections of the hydrogeologic conditions, showing existing conditions and anticipated conditions once the site has been established;
 - vi. a description of the background quality of the groundwater, and the existing and potential uses of the groundwater;
 - vii. a description of the existing and predicted flow velocity, and volumetric flow rate in the aquifers;
 - viii. a water balance analysis considering precipitation, surface water drainage, infiltration, groundwater flow, exfiltration, and evapotranspiration under existing conditions, during operation of the site and following closure; and
 - ix. the potential flow directions, extent of migration, and contaminant attenuation capabilities in the event leachate leaves the waste fill area in planned or unplanned quantities; and
- e. an assessment of the suitability of the site for waste disposal purposes considering the regional, local, and site specific hydrogeologic conditions, the design of the site, and the contingency plans for the control of leachate and landfill gas.

5. Surface Water Assessment

Prior to the establishment or expansion of a site, a report shall be prepared by the owner containing plans, specifications, and descriptions of the surface water

conditions of the site, adjacent and nearby properties, and the regional area in which the site is located, including, at a minimum, the following:

- a. a general description of the surface water features occurring within 5 km of the site that is based on the contributing/receiving drainage area, catchment, subwatershed or watershed that is sufficiently large to assess the range and extent of potential effects. This description will include, but not be limited to, flood plains, natural watercourses, drainage paths and boundaries, streamflows, surface water quality, and sources of water supply;
- b. a description of the local surface water features occurring at the site, and adjacent and other properties within 500 m of the site, and the description shall include how local features relate to regional features;
- c. a detailed surface water investigation of the site to assess water quality, quantity, and habitat conditions of the surface water features identified on site, including:
 - i. a surface water quantity program to assess current (baseline) streamflow conditions that includes periodic measurements of streamflows (e.g., peak flows, baseflows, etc.) a minimum of twice monthly for one year;
 - ii. a surface water quality program to assess current (baseline) surface water quality over the period of one year, with surface water samples obtained:
 - once and analyzed for Dissolved Organic Carbon, the volatile organics listed in column 1 of Schedule 1, and compounds known to be in industrial or agricultural use in the proposed site's watershed to assess whether any of these should be included in the surface water monitoring program;
 - semi-annually and analyzed for the parameters listed in column 3 of Schedule 1;
 - monthly and analyzed for the parameters listed in column 4 of Schedule 1; and
 - iii. benthic community inventory to establish existing conditions;
- d. an interpretation of the results of the detailed surface water investigation of the site, including the following plans, specifications, and descriptions:

- i. regional and local site plans showing all existing surface water features;
- ii. a description of background (baseline) surface water quality and the existing and potential surface water uses, to include:
 - summary of sampling results;
 - review of data available from other sources, including the provincial surface water quality monitoring network for stations upstream and downstream of the proposed site;
 - a discussion of the underlying trends in water quality in the watershed (where possible);
- iii. detailed hydrologic assessment of the surface water features, including:
 - changes to the frequency, magnitude, and duration of streamflows at key locations entering, passing through, and discharging from the site;
 - changes to the magnitude and duration of streamflow velocities in watercourses at key locations entering, passing through, and discharging from the site;
 - changes to surface water flood levels within watercourses entering, passing through, and discharging from the site that have an upstream drainage area > 125 ha;
 - changes to average annual water budgets, including evapotranspiration, infiltration, surface runoff, and groundwater recharge/discharge volumes expressed over the site area and the contributing drainage area; and
 - changes to average annual sediment loading to receiving watercourses at key locations discharging from the site;
- iv. the potential leachate flow directions, extent of migration, and location of intersection with surface water features in the event leachate leaves the waste fill area in planned or unplanned quantities; and

- e. an assessment of the suitability of the site for waste disposal purposes considering the regional, local, and site specific surface water conditions, the design of the site, and the contingency plan for the control of leachate.

6. Design Specifications

Prior to the establishment or expansion of a site, a report shall be prepared by the owner containing plans, specifications, and descriptions of the design of the site, including, at a minimum, the following:

- a. a legal survey of the site showing all property boundaries, buildings, utilities, roads, land contours, surface water drainage and water bodies, right-of-ways, forested areas, land use, and other property conditions that existed before establishing or expanding the site;
- b. a plan of the site and vicinity, including adjacent properties and any other properties within 500 m of the site, showing all property boundaries, buildings, roads, land contours, surface water drainage and water bodies, right-of-ways, forested areas, land uses, and other property conditions that existed before establishing or expanding the site;
- c. detailed plans, specifications, and descriptions for the design of the site, including:
 - i. the waste fill area, including top contours for waste disposal, top contours with final cover, base contours for waste disposal, and base contours for the leachate control system;
 - ii. the maximum volume of waste and cover material that may be deposited within the waste fill area;
 - iii. a materials balance between the sources and uses of soils at the site;
 - iv. a geotechnical assessment of the suitability of the site for waste disposal;
 - v. the type of waste to be landfilled and a characterization of the expected quality and quantity of leachate;
 - vi. final cover, including construction and quality assurance/quality control procedures;

- vii. where necessary to control leachate, the liner system, including construction and quality assurance/quality control procedures;
- viii. where necessary to control leachate, the leachate collection, treatment, and disposal system, including construction and quality assurance/quality control procedures;
- ix. where necessary to control landfill gas, the landfill gas venting system, or the collection and burning, or utilization, system;
- x. the surface water and sediment control and discharge system;
- xi. monitoring facilities for leachate, groundwater, surface water, and landfill gas;
- xii. an assessment of potential noise sources and receptors using the MOEE Noise Guidelines for Landfill Sites (January 1993);
- xiii. the buffer zone and ancillary facilities, including screening and landscaping, site fencing, buildings and structures, site access and internal roads, areas for receipt of materials for recycling and rejected waste, weigh scales, and signage;
- xiv. any contaminant attenuation zone;
- xv. an estimation of the contaminating life span of the site for leachate and landfill gas, an estimation of the service life of any control facilities for leachate and landfill gas, and the design of any facilities intended to control or alter the contaminating life span or service life;
- xvi. plans, specifications, and descriptions to a level of detail sufficient to demonstrate the feasibility of contingency plans for the construction of facilities for the control and disposal of leachate and landfill gas in the event that leachate or landfill gas leaves the site in unplanned quantities;
- xvii. the appearance of the site after closure, and the construction of new facilities or the removal of existing facilities needed for closure, post-closure, and site end use activities; and
- xviii. a summary table of key facility characteristics, including accepted waste types, prohibited waste types, maximum annual rate of waste receipt, site area, waste fill area, total waste

disposal volume, estimated waste disposal capacity (tonnes), and estimated site life (years).

7. Design Criteria for Groundwater Protection

The site shall be designed to protect groundwater in accordance with either one of Subsection 7.a., 7.b., or 7.c. below.

- a. Unless otherwise permitted by the Ministry's Reasonable Use Guideline (MOEE, 1994), the design of a new or expanded site shall be such that it is sufficient to prevent any contaminant listed in Table A, unless other contaminants can be justified as more appropriate, and originating from the site from causing an increase in the concentration in the groundwater on any adjacent property that would exceed the maximum allowable concentration (C_m) given by Equation 7.1 within a period of 1,000 years.

$$[7.1] \quad C_m = C_b + x(C_r - C_b),$$

where, C_r is the drinking water objective, C_b is the background concentration of the particular parameter in the groundwater before it has been affected by human activity, and x is a constant that is considered by the Ministry to have only a negligible effect on the use of the water. For drinking water, x is 0.5 for aesthetic (non-health related) parameters and x is 0.25 for health related parameters.

The background concentration, C_b , of a parameter shall be taken to be the median value of the data (minimum of five data points) for that parameter based on all groundwater samples taken from the receptor aquifer at or near the site boundary where the potential impact is being examined.

The source concentrations and half-lives given in Table A shall be used for the purposes of evaluating the design with respect to this requirement. Also, the service lives specified in Tables B1, B2, B3, and B4 for various components of the engineered system are applicable for the purpose of evaluating the design with respect to this requirement provided that the conditions given in Tables B1, B2, B3, and B4 are met. The impact assessment shall consider both advective and diffusive contaminant transport and shall include examination of the effect of the failure of engineered systems when their service lives are reached.

or:

- b. For a new site with less than an average of 90,000 m³ of waste disposal volume (landfill final cover excluded) per hectare of waste fill area, with an

infiltration rate through the landfill final cover greater than or equal to 0.15 metres/annum, where the background concentration of chloride in the aquifer is less than 50 mg/L, and where there is either an attenuation layer naturally present at the base of the landfill which is relatively homogeneous, at least 3 m thick, and with a bulk hydraulic conductivity of less than or equal to 1×10^{-7} m/s, or an engineered layer meeting these criteria that is installed where this attenuation layer is not naturally present, the design of the landfill shall include a groundwater protection system below the waste consisting of, from bottom to top:

- i. a primary composite liner consisting of a compacted clayey liner at least 0.75 m thick that is compacted in at least five lifts of 0.15 m maximum compacted thickness to have a hydraulic conductivity of no more than 1×10^{-9} m/s and that has an organic carbon content of at least 0.1%, overlain by a high density polyethylene (HDPE) geomembrane liner at least 2 mm (80 mil) thick installed in direct and uniform contact with the compacted clayey liner in such a way as to not cause puncture or load-induced damage.
- ii. a primary leachate collection system that meets the requirements for a 100 year service life as set out in Table B1 and is separated from the geomembrane by a material to protect the geomembrane from puncture and load-induced damage.

or:

- c. For a new site with less than an average of 250,000 m³ of waste disposal volume (landfill final cover excluded) per hectare of waste fill area, with an infiltration rate through the landfill final cover greater than or equal to 0.15 metres/annum, where the background concentration of chloride in the aquifer is less than 50 mg/L, and where there is either an attenuation layer naturally present at the base of the landfill which is relatively homogeneous, at least 1 m thick, and with a bulk hydraulic conductivity of less than or equal to 1×10^{-7} m/s, or an engineered layer meeting these criteria that is installed where this attenuation layer is not naturally present, the design of the landfill shall include a groundwater protection system below the waste consisting of, from bottom to top:
 - i. a secondary composite liner consisting of a compacted clayey liner at least 0.75 m thick that is compacted in at least five lifts of 0.15 m maximum compacted thickness to have a hydraulic conductivity of no more than 1×10^{-9} m/s and that has an organic carbon content of at least 0.1%, overlain by a high density

polyethylene (HDPE) geomembrane liner at least 2 mm (80 mil) thick installed in direct and uniform contact with the compacted clayey liner in such a way as to not cause puncture or load-induced damage.

- ii. a secondary leachate collection system that meets the requirements for a 1000 year service life as set out in Table B2 and is separated from the geomembrane by a material to protect the geomembrane from puncture and load-induced damage.
- iii. a primary composite liner consisting of a compacted clayey liner at least 0.75 m thick that is compacted in at least five lifts of 0.15 m maximum compacted thickness to have a hydraulic conductivity of no more than 1×10^{-9} m/s and that has an organic carbon content of at least 0.1%, overlain by a high density polyethylene (HDPE) geomembrane liner at least 2 mm (80 mil) thick installed in direct and uniform contact with the compacted clayey liner in such a way as to not cause puncture or load-induced damage.
- iv. a primary leachate collection system that meets the requirements for a 100 year service life as set out in Table B1 and is separated from the geomembrane by a material to protect the geomembrane from puncture and load-induced damage.

TABLE A : Leachate Characteristics

Parameter	Initial Source Concentration (mg/L)	Mass as a proportion of total (wet) mass of MSW (mg/kg) ²	Half-Life in MSW Leachate (years) ²	Health Related Drinking Water Objective (mg/L)	Aesthetic Drinking Water Objective (mg/L)
Benzene	0.02	0.014	25	0.005	
Cadmium	0.05	0.035	n/a	0.005	
Chloride ¹ ≤ 150,000 t/ha increasing to ≥ 250,000 t/ha	1,500 increasing to 2,500	1,800	n/a		250
Lead	0.6	0.42	n/a	0.01	
1,4 Dichlorobenzene	0.01	0.007	50	0.005	0.001
Dichloromethane	3.3	2.3	10	0.05	
Toluene	1.0	0.7	15		0.024
Vinyl Chloride	0.055	0.039	25	0.002	

Notes:

1. The initial (peak) source concentration of chloride is taken to vary with tonnes/ha of MSW, with a linear variation between 150,000 and 250,000 t/ha.
2. Half-lives can be used in considering a decrease in source concentration with time and for estimating the contaminating life span.
3. The source of parameter values for source concentration, mass proportion, and half-life appearing on this table (other than the initial source concentration of chloride - see Note 1) is R. Kerry Rowe Inc., October 1994, *Leachate Characterization*, prepared for the Interim Waste Authority Ltd. The half-life of toluene in leachate has been rounded up from 12.5 years to 15 years.

**TABLE B1: Service Life of the Primary Leachate Collection System
(may be used for option a, b, or c)**

The primary leachate collection system may be assumed to have a Service Life of 100 years, starting from year 10 or the mid-point of the operating site life, whichever is less, provided that:

1. There is a minimum 0.5 m thick continuous layer across the landfill base (including side slopes) of granular material ('stone') with a nominal diameter (D_{85}) of not less than 37 mm, a D_{10} of not less than 19 mm, a uniformity coefficient ($CU = D_{60}/D_{10}$) of less than 2, and no more than 1% passing the US # 200 sieve.
2. A suitable geotextile or graded granular filter/separator is installed between the stone layer and the overlying waste and any underlying soil.
3. There are HDPE perforated leachate collection pipes with a minimum of 150 mm internal diameter and with perforations not less than 12 mm diameter at spacings of 0.1 m between staggered locations at 120° around the pipe.
4. The perforated leachate collection pipes across the landfill base (excluding side slopes) are at a spacing such that the maximum drainage path before leachate can potentially intercept a collection pipe is no more than 50 m.
5. The minimum thicknesses of granular material above and below the perforated leachate collection pipes are 250 mm and 50 mm, respectively.
6. The leachate collection pipes are designed to have adequate structural capacity.
7. Leachate collection pipes will be regularly cleaned and inspected, at least annually for the first five years after placement of waste overtop of each pipe and then at a frequency indicated to be necessary by the inspection.
8. Leachate is removed from the collection system such that the leachate head at any point in the system does not exceed 0.3 m.
9. The landfill base is contoured to provide minimum surface grades of 0.5 % toward the leachate collection pipes.
10. No sludge is disposed of in a manner that would allow sludge to move into the leachate collection system and promote biological clogging.

The service life of the leachate collection system can be assumed to be 75 years, starting from year 10 or the mid-point of the operating site life, whichever is less, provided that:

- (i) the thickness of the stone layer in (1) above is a minimum of 0.3 m;
- (ii) the minimum thicknesses of granular material above and below the perforated leachate collection pipes in (5) above are met (may require localized thickening of granular drainage layer);
- (iii) the maximum drainage path in (4) above is no more than 25 m; and
- (iv) all other conditions itemized above are met.

TABLE B2: Service Life of the Secondary Leachate Collection System (may be used for option a or c)

The secondary leachate collection system may be assumed to have a Service Life of 1000 years, starting from year 10 or the mid-point of the operating site life, whichever is less, provided that:

1. There is a minimum 0.3 m thick continuous layer across the landfill base (including side slopes) of granular material ('stone') with a nominal diameter (D_{85}) of not less than 37 mm, a D_{10} of not less than 19 mm, a uniformity coefficient ($CU = D_{60}/D_{10}$) of less than 2, and no more than 1% passing the US # 200 sieve.
2. A suitable geotextile or graded granular filter/separator is installed between the stone layer and any overlying and underlying soil.
3. There are HDPE perforated leachate collection pipes with a minimum of 150 mm internal diameter and perforations of not less than 12 mm, at spacings of 0.1 m between staggered locations at 120° around the pipe.
4. The perforated leachate collection pipes across the landfill base (excluding side slopes) are at a spacing such that the maximum drainage path before leachate can potentially intercept a collection pipe is no more than 100 m.
5. The minimum thicknesses of granular material above and below the perforated leachate collection pipes are 250 mm and 50 mm, respectively (may require localized thickening of granular drainage layer).
6. The leachate collection pipes are designed to have adequate structural capacity.
7. The leachate collection pipes will be inspected annually and cleaned at a frequency indicated to be necessary by the inspection.
8. Leachate is removed from the collection system such that the leachate head at any point in the system does not exceed 0.3 m.
9. The landfill base is contoured to provide minimum surface grades of 0.5% toward the leachate collection pipes.

TABLE B3: Service Life of Geomembrane Liners (may be used for option a, b, or c)

The service life of a 2 mm (80 mil) thick HDPE geomembrane used as part of a primary composite liner (i.e., in contact with raw leachate) may be taken to be 150 years, starting from year 10 or the mid-point of the operating site life, whichever is less, provided that:

1. the geomembrane is installed in direct and uniform contact with a suitable clayey liner or foundation;
2. the geomembrane is protected against puncturing and load-induced damage;
3. particular care is taken to remove wrinkles in the geomembrane and to minimize stress concentration (e.g., at corners, pipe and maintenance hole penetrations, etc.);
4. appropriate measures are taken during construction to ensure high quality seams;
5. appropriate measures are taken to minimize:
 - differential settlement;
 - exposure to ultraviolet light;
6. appropriate measures are taken to prevent damage due to:
 - sliding;
 - installation in cold conditions;
 - rodents.

Geomembranes used as a secondary (or subsequent) liner or part of a secondary (or subsequent) composite liner may be taken to have a service life of 350 years, starting from year 10 or the mid-point of the operating site life, whichever is less, provided that all conditions itemized above are met.

TABLE B4: Service Life of Compacted Clayey Liners (may be used for option a, b, or c)

The service life of compacted clayey liners may be taken to be indefinite (thousands of years) provided that:

1. the liner is at least 0.75 m thick and is compacted in at least five lifts of 0.15 m maximum compacted thickness;
2. appropriate mineralogical studies or other leachate compatibility studies indicate that the clay is not likely to experience a significant increase in hydraulic conductivity due to interaction with MSW leachate;
3. appropriate measures are taken during construction to control:
 - soil properties and water content;
 - breakup of clods;
 - lift thickness and compaction;
 - hydraulic conductivity;
 - stones larger than 100 mm;
4. appropriate measures are taken to prevent:
 - desiccation of the compacted clayey liner;
 - damage to compacted clayey liner due to freezing;
 - damage to compacted clayey liner due to rodents;
5. appropriate measures are taken to prevent damage due to differential settlement; and
6. a suitably qualified geotechnical engineer reports that there was no evident cracking or macrostructures in the constructed liner.

8. Groundwater Protection System

- a. Irrespective of whether the groundwater protection system is designed in accordance with Subsection 7.a., 7.b. or 7.c., the design plans and report shall provide sufficient detail to allow construction and operation of the landfill. The design report shall include:
 - i. a description of the foundation design and materials of construction, including a discussion of the capability of the foundation to support any expected static and dynamic loadings;
 - ii. data showing fluctuations in the depth of the water table and the seasonal high and low watertable in relation to the foundation or liner system;
 - iii. sufficient data to evaluate the engineering properties of the foundation and, if proposed, the clayey liner materials. This shall include data relating to the Atterberg limits, organic carbon content, grain size distribution, mineralogy, strength, hydraulic conductivity, compressibility and, when appropriate, compaction curves. The report should also clearly indicate other parameters used by the designer (e.g., diffusion coefficients, K_{α} , effective porosity, any other parameter used in the design or analysis) and provide data and/or references supporting the choice of these parameters.
 - iv. to address the issue of clay/leachate compatibility, data showing that there will be no significant increase in hydraulic conductivity or reference given to tests that have been conducted on soil that is mineralogically similar using a leachate similar to that anticipated for the proposed undertaking;
 - v. engineering analyses, based on the data gathered through subsurface exploration and laboratory testing programs, that provide:
 - estimates of the total and differential settlement, including immediate settlement and primary and secondary consolidation, with particular attention paid to maintenance holes;

- estimates of the bearing capacity and stability of the foundation which demonstrate that the allowable bearing capacity will not be exceeded, with particular attention paid to maintenance holes;
 - estimates of the potential for bottom heave or blow-out due to hydrostatic or gas pressures;
 - evidence that the foundation is capable of providing adequate support for operating and construction equipment;
- vi. a description of construction and installation procedures. If a compacted clayey liner is proposed, include details regarding the control of compaction water content, lift thickness, equipment to be used, scarification between lifts, limits on clod size, removal of stones, and procedures to avoid desiccation of the clayey liner. Liner test sections shall be constructed to develop and confirm construction procedures;
- vii. a description of the inspection, monitoring, sampling, and testing methods and frequencies to be employed to assure that the foundation and, where present, liner(s) meet the design requirements;
- viii. a description of any soil additives that are proposed, the concentrations to be added and the methods that will be used to mix and spread the material;

If a geomembrane liner is proposed, the following information shall also be provided:

- ix. a description of the proposed geomembrane (type, thickness, texture, etc.);
- x. design specifications for the raw polymer and manufactured sheet (e.g., density, melt index, carbon black, tensile properties, tear resistance, carbon black dispersion, dimensional stability);
- xi. requirements for delivery, storage, installation and sampling of the geomembrane;

- xii. calculations of the physical stress, including those due to:
- differential settlement of the foundation soils;
 - strain requirements at the anchor trench; and
 - strain requirements over long, steep side slopes;
- xiii. a statement on the chemical compatibility of the liner and the leachate and cite the basis for the statement.
- xiv. a description of how the short-term stresses such as equipment traffic during installation and thermal effects during construction and operation will be taken into account. The liner must be able to withstand the stresses resulting from application of the protection layer placed between the liner and the leachate collection system.
- xv. a demonstration that there will be adequate friction between the components of the liner system so that slippage and sloughing does not occur on the slopes of the facility. Specifically, using design equations, evaluate:
- the ability of the geomembrane to support its own weight on the side slopes;
 - the ability of the geomembrane to withstand down-drag during and after waste placement;
 - the suitability of the anchorage configuration for the geomembrane; and
 - the stability of any protection layer above the geomembrane;
- xvi. installation specifications, including details regarding:
- visual inspection of the suitability of the subgrade;

- methods of dealing with thermal expansion and contraction that will prevent impairment of the geomembrane's service life;
- methods of protecting the geomembrane during shipping, storage, and handling;
- deployment of the geomembranes at the construction site (include a panel layout plan), seam preparation, seaming methods, seaming temperature constraints;

xvii. inspection activities, including both non-destructive and destructive quality control field testing of sheets and seams during installation of the geomembrane. Describe how the following will be taken into account:

- ambient temperature at which seams are made;
- relative humidity;
- control of panel uplift by wind;
- wrinkles;
- effects of cloud cover and direct sunlight on geomembrane temperature;
- water content of subsurface beneath geomembrane;
- supporting surface on which the seam is bonded;
- skill of the seaming crew;
- quality and consistency of the chemical or welding material;
- proper preparation of the liner surfaces to be joined; and
- the cleanliness of the seam interface (e.g., amount of airborne dust);

xviii. a specification for liner strength and the calculations defining the minimum strength requirement considering:

- internal and external pressure gradients;
- stresses resulting from settlement, compression, or uplift;
- climatic conditions;
- installation stresses; and
- operating stresses;

- xix. a specification for the geomembrane protection layer that will be placed between the geomembrane and the leachate collection system, including the method of placement;

If a primary or secondary leachate collection system is proposed, the following information shall also be provided:

- xx. a description of the proposed leachate collection system, including estimated leachate flows, drainage layer design, any pipe network, and the leachate removal system;
- xxi. design specifications, calculations, and descriptions of design and operational measures that demonstrate that the leachate collection system either meets the requirements of Tables B1 and B2 or will provide the service life and leachate head control assumed in the assessment of groundwater impact under Subsection 7.a. by addressing:
- the gradation (nominal diameter, uniformity coefficient, silt content), drainage path length, thickness normal to leachate drainage, surface grades of the landfill base, leachate compatibility, biological/chemical clogging potential, and hydraulic conductivity of the granular drainage materials;
 - the long-term transmissivity under final loads, biological/chemical clogging potential, and leachate compatibility of any geosynthetic drainage layers;
 - the geotextile or graded granular filter/separator between the waste and the drainage medium; and
 - the material, internal diameter, wall thickness, perforation size and location and spacing, flow capacity, structural capacity (wall crushing, pipe deflection, critical buckling pressure), access for cleaning, and the inspection and cleaning schedule of any collection pipes;

xxii. a demonstration that the side slopes of the leachate collection system will be stable. Specifically, using design equations, evaluate:

- the stability of the granular drainage materials on the underlying soil or geomembrane;
- the stability between the components of any geosynthetic drainage layer (geotextiles, geonets) and between the geosynthetic drainage layer and the underlying soil or geomembrane;
- the ability of any geosynthetic drainage layer to support its own weight on the side slopes;
- the ability of any geosynthetic drainage layer to withstand down-drag during and after waste placement;
- the suitability of the anchorage configuration for the geosynthetic drainage layer; and
- the stability of any filter/separator layer above the geosynthetic drainage layer;

xxiii. installation specifications, including details regarding:

- equipment used in granular drainage layer placement;
- methods to control granular drainage layer thickness;
- bedding depth for any collection pipes;
- method of joining collection pipes;
- method of placement and seaming, if any, of geosynthetic drainage layers; and
- method of placement of any filter/separator layer above the drainage layer;

- b. Irrespective of whether the groundwater protection system is designed in accordance with Subsection 7.a., 7.b., or 7.c. the design report shall include a quality assurance plan that addresses both construction material quality control (CQC) and construction quality assurance (CQA), as they pertain to (as applicable):

- the foundation;
- compacted clayey liners;
- geomembrane liners;
- protection layers for geomembrane liners;
- leachate collection systems; and
- filter/separator layers for leachate collection systems.

The CQC/CQA plan shall describe in detail the responsibilities of the construction quality control officer as they pertain to:

- communicating with the contractor;
- interpreting and clarifying project drawings and specifications with the designer, owner, and contractor;
- recommending acceptance or rejection by the owner/operator of work completed by the construction contractor;
- submitting blind samples (e.g., duplicates) for analysis by the quality control laboratory and one or more independent laboratories;
- notifying the owner/operator of construction quality problems not resolved on-site in a timely manner;
- observing the testing equipment, personnel, and procedures used by the construction contractor to check for detrimentally significant changes over time;
- reviewing the quality control records, maintenance, summary, and interpretation of test data for accuracy and appropriateness; and
- reporting to the owner/operator on monitoring results.

9. Leachate Disposal

The plans, specifications, and descriptions for the disposal of leachate collected at the site shall include, at a minimum:

- a. the handling, treatment, and discharge of leachate directly to a waterbody such that the plans, specifications, and descriptions provide a level of

detail sufficient to demonstrate the feasibility of obtaining approval under the Ontario Water Resources Act; or

- b. the handling, treatment, and discharge of leachate into an existing sanitary sewer or sewage works approved under the Ontario Water Resources Act, including:
 - i. the location and owner of the sanitary sewer, if any, and the sewage works;
 - ii. the transportation or piping of leachate to the sanitary sewer or sewage works;
 - iii. the acceptance criteria for discharge to the sanitary sewer, if any, and the sewage works;
 - iv. an assessment of the impact on the sanitary sewer, if any, the sewage works, and the receiving waterbody based on the expected quality and quantity of leachate to be discharged;
 - v. any treatment required prior to acceptance of the leachate; and
 - vi. the written agreement of the owner of the sanitary sewer, if any, and the sewage works for acceptance of the leachate.

10. Leachate Contingency Plan

The plans, specifications, and descriptions for the contingency plan to collect leachate at the site, in the event the liner or leachate collection system fails, or where leachate otherwise leaves the waste fill area in an amount which may result in the concentration of any contaminant leaving the site being in excess of the concentration defined for the site in accordance with the Ministry's Reasonable Use Guideline (MOEE, 1994) shall include, at a minimum, the following:

- a. the construction of purge wells or other system into the waste or within the buffer zone to remove leachate or groundwater such that the impact on adjacent properties would be in accordance with the Ministry's Reasonable Use Guideline (MOEE, 1994). If purge wells are the method of leachate removal from within the waste, the contingency plan should provide calculations of the number of wells likely to be required, the expected well spacing, and the level of leachate mound

control that can be realistically expected. In the absence of data, the hydraulic conductivity of the waste should be based on $k = 10^{-6}$ m/s for waste depths of 10 m or less, $k = 10^{-7}$ m/s for waste depths of 10 - 30 m, and $k = 10^{-8}$ m/s for waste depths in excess of 30 m;

- b. the handling, treatment, and disposal of the collected leachate or groundwater;
- c. the provision of an alternative water supply to adjacent properties and any other properties in the vicinity of the site that may be affected by the release of leachate into the groundwater in an amount in excess of the amount defined for the site in accordance with the Ministry's Reasonable Use Guideline (MOEE, 1994); and
- d. an implementation strategy for the contingency plan, including;
 - i. a predictive monitoring program designed to identify potential increases in groundwater contaminant concentrations at the property boundary prior to the increases occurring. This predictive monitoring program shall include the placement of groundwater monitoring wells in the buffer area sufficiently close to the landfill that they would provide adequate warning of potential exceedance of allowable concentrations (as defined by Equation 7.1 and the Ministry's Reasonable Use Guideline) prior to an exceedance occurring at the site boundary. The changes in concentration due to landfilling activities, relative to background values, shall be compared with the impact response criteria defined below and the trigger criteria to be developed in accordance with Subsection 10.d.ii.

The increase in concentration of any contaminant for initiating the impact response plan (impact response criterion) will be taken to be one-half the allowable concentration increase under the Ministry's Reasonable Use Guideline. If the increase in concentration above background values of any contaminant exceeds the impact response criterion for two subsequent sampling events, an investigation into the cause of the

increase and preparation of an impact response plan described in Subsection 10.d.ii. shall be initiated. Groundwater monitoring shall continue until the peak increase of all parameters has occurred and concentrations are declining.

- ii. an impact response plan describing the activities and timing of the activities to be carried out, including setting trigger criteria based on the maximum acceptable concentrations for the site in accordance with the Ministry's Reasonable Use Guideline (MOEE, 1994) for implementation of the works identified in Subsections 10.a., 10.b., and 10.c.; and
- iii. where the monitoring program and impact response plan indicate the contingency plan needs to be implemented, the owner shall notify the Director of the need to implement the contingency plan, prepare detailed plans, specifications, and descriptions for the design and operation of the contingency plan, and implement the contingency plan.

11. Surface Water Control

- (1) Prior to the establishment or expansion of a site, a report shall be prepared by the owner containing plans, specifications, and descriptions for the control, treatment, and discharge of surface water at the site during site operation and following closure, including, at a minimum, the following:
 - a. a site drainage plan showing the drainage of surface water at the site before the site is established, during operation of the site, and following site closure;
 - b. a description of the design features, control facilities, and operational procedures to isolate, contain, convey, control, and/or treat the surface water on and off site prior to its discharge to the receiving watercourse(s). The description should consider the following surface water flows:
 - i. clean surface water - off-site surface water flows that have been separated from landfill site operations by means

of diversions, berms, interceptor channels, etc.;

- ii. non-contaminated storm water - on-site runoff originating from non-operating areas, that does not contact landfill waste, leachate, or wastewater, but may originate from parking and loading areas, buildings, stockpiles, etc.; and
 - iii. contaminated storm water - on-site runoff originating from landfilling areas, material and waste storage areas, and areas designed for the collection, storage, or treatment of leachate;
- c. the design and location of any surface water control features, such as berms, swales, ditches, control ponds, facilities and/or other storm water management practices (SWMPs) for the control of the quality and quantity of surface water from the site. The design shall be in accordance with the following:
- i. the design of any surface water control features, such as berms, swales, ditches, control ponds and/or other facilities for the control of the quality and quantity of surface water from the site shall be based on accepted methodologies, calculations and analytical tools, including, but not limited to: hydrologic computer modelling (both single event and continuous simulations), hydraulic computer modelling, and water quality modelling, using accepted computer models and techniques;
 - ii. the design of any external diversion channels, ditches, and conveyance structures shall be sized to accommodate the peak flow generated from the higher of the 100-year design storm or the prevailing Regional Storm Event (e.g., Hurricane Hazel, Timmins, or other historically observed maximum event);
 - iii. the design of all internal drainage ditches, storm sewers, and conveyance

structures shall be sized to accommodate the peak flow generated from a 25-year design storm. A continuous overland flow route and/or ditch drainage system shall be provided and sized to convey the peak flow generated from the higher of the 100-year design storm or the prevailing Regional Storm Event;

- d. the design and location of all sedimentation ponds to remove sediment from any surface water control facilities constructed at the site. The design shall be in accordance with the following:
 - i. the design of any storm water management facilities for the purpose of surface water quality enhancement (i.e., settling of suspended sediment) of non-contaminated storm water shall be designed to temporarily treat/store the runoff volume generated from a 4-hour, 25 mm storm event;
 - ii. the design of any storm water management facilities for the purpose of surface water quantity control (i.e., peak flow reduction) of non-contaminated storm water shall be designed to temporarily store the runoff volume generated from controlling all storm events up to the higher of the 24-hour, 100-year design storm or the prevailing Regional Storm event, at or below the existing condition (i.e., pre-landfill) peak flows, such that there is no appreciable change in the potential for flooding and/or erosion in the watercourses receiving surface water discharges from the landfill site;
- e. the design and location of any temporary or permanent erosion and sediment control measures for the site, including any surface water control, treatment, and discharge facilities, or any areas in which construction/operation activities are taking place;
- f. the design and location of any overflow control provisions for the site to safely convey storm water flows in excess of the specified design storm; and

- g. a description of the operation, inspection, and maintenance requirements for any storm water management practices (SWMPs), including erosion and sediment control facilities;
- 2) The design of the site shall be such that:
 - a. the concentration of any contaminant in surface water being discharged from the site to a waterbody is no greater than the concentration defined in accordance with the Ministry's Water Management Guidelines (MOEE, 1994); and
 - b. the background levels for dissolved oxygen (DO), turbidity, and temperature, and the hydrologic cycle of any on-site, adjacent, or down-gradient surface water feature are not adversely affected by the site.

12. Sub-Surface Migration of Landfill Gas

- (1) Prior to the establishment or expansion of a site, a report shall be prepared by the owner containing plans, specifications, and descriptions for the assessment, monitoring, control, and discharge of landfill gas at the site, including, at a minimum, the following:
 - a. an assessment of the potential for landfill gas generation and migration below land surface, including, at a minimum:
 - i. background concentrations of methane gas and any existing potential sources of methane gas generation;
 - ii. the potential for generation of landfill gas, including methane gas;
 - iii. the potential for migration within the buffer zone and off site to adjacent or other properties; and
 - iv. the potential for migration within any buried utility or service lines;
 - b. an owner may request an exemption from monitoring if the assessment in Subsection 12(1)a. shows that no potential for landfill gas migration exists below land surface within the buffer zone, in adjacent or other off-site properties, and within buildings or enclosed structures located off-site;

- c. where methane gas may be generated at the site, the report shall include, at a minimum, the provision of methane gas monitoring devices, with detection alarms, for any building or enclosed structure located on site which is accessible by any person or contains electrical equipment or any potential source of ignition;
- d. where monitoring of the potential migration of landfill gas is to be carried out, the report shall include, at a minimum, the design of the monitoring devices, the monitoring locations, frequency and period of monitoring, and the parameters to be analyzed, including the concentration of methane gas and the gas pressure within the monitoring devices;
- e. a contingency plan to control landfill gas migration below land surface to be implemented in the event landfill gas leaves the waste fill area at concentrations identified in Subsection 12(2), including, at a minimum:
 - i. a conceptual design of the control facilities;
 - ii. an impact response plan and schedule describing activities to be carried out in the event of an increase in landfill gas concentrations within the buffer zone, off site, or within buildings; and
 - iii. where the monitoring program indicates the contingency plan needs to be implemented, the owner shall notify the Director of the need to implement the contingency plan, prepare detailed plans, specifications, and descriptions for the design and operation of the contingency plan, and implement the contingency plan;

(2) Where methane gas may be generated at a site, the site shall be designed to control the migration of landfill gas below the surface of the land in accordance with the following criteria:

- a. the concentration of methane gas below the surface of the land at the boundary of the site shall be less than 5 percent by volume;

- b. the concentration of methane gas in any on-site building or enclosed structure, or in the area immediately outside the foundation or basement floor of the building or enclosed structure, which is accessible by any person or contains electrical equipment or any potential source of ignition, shall be less than 1 percent by volume; and
- c. methane gas from the site shall not be present in any off-site building or enclosed structure, or in the area immediately outside the foundation or basement floor of the building or enclosed structure, which is accessible by any person or contains electrical equipment or any potential source of ignition.

13. Atmospheric Emissions of Landfill Gas

- (1) Where the total waste disposal volume at a new or expanded site is greater than 3.5 million m³, the site shall be designed to include facilities for the collection and burning, or utilization, of landfill gas generated by the site during site operation and following closure.
- (2) The requirements of Subsection 13(1) do not apply where the owner prepares a report showing that, based on the type of waste to be deposited, significant quantities of landfill gas will not be generated at the site.

14. Design Criteria for Engineered Facilities

An engineered facility which is to be constructed at a site for purposes of controlling leachate, groundwater, surface water, or landfill gas shall be designed such that:

- a. the service life of the engineered facility exceeds the contaminating life span of the site with respect to the purpose of the engineered facility; or
- b. the engineered facility can be replaced, as necessary throughout the contaminating life span of the site with respect to the purpose of the engineered facility.

15. Final Cover

- (1) The final cover of the landfill shall include a minimum 1 m of cover material and shall be designed such that:
 - a. the waste is isolated from the surface environment;

- b. vegetative cover is supported;
 - c. the infiltration requirements for groundwater protection are met;
 - d. the requirements for control of landfill gas are met; and
 - e. the requirements for end use are met.
- (2) The concentrations of contaminants in soil used for final cover shall not be in excess of the concentrations (Note: surface criteria) specified in the Ministry's Clean-up Guidelines for the intended land use for the site upon closure.

16. Final Slopes

The final slopes above grade within the waste fill area of the site shall not exceed one unit vertical to four units horizontal and shall not be less than one unit vertical to twenty units horizontal unless an alternative design for the final slopes is necessary to facilitate the proposed end use of the site or ensure the infiltration requirements for groundwater protection are met.

17. Design Criteria for Noise

Unless otherwise permitted by the Ministry's Noise Guidelines for Landfill Sites (MOEE, 1993) the design and operation of the site shall be such that the maximum sound level measured on the off-site property of any person due to operation of the site shall be the greater of the background level, or, 55 dBA from 7:00 am to 7:00 pm and 45 dBA from 7:00 pm to 7:00 am.

18. Buffer Zone

The buffer zone between the edge of the waste fill area and the property boundaries of the site shall not be less than 100 m wide unless the owner prepares a report showing that the potential impacts from the site are acceptable with a reduced buffer zone width, but in no case shall the buffer zone be less than 50 m wide.

19. Site Preparation Report

Prior to disposing of any waste in a newly constructed waste fill area or section thereof, a report shall be prepared by the owner documenting all construction and quality assurance/quality control activities and confirming that the

conditions and construction of the new area are in accordance with the design plans and specifications of the site and shall include, at a minimum, the following:

- a. hydrogeologic conditions found during excavation or drilling activities carried out for the new waste fill area, and for new control or monitoring facilities;
- b. the construction and testing of any liner system;
- c. the construction of any other new control, treatment, disposal, or monitoring facilities for leachate, groundwater, surface water, and landfill gas; and
- d. the construction of any other works or facilities, including screening, landscaping, on-site roads, fencing and other structures.

Operation and Monitoring

20. Operation & Maintenance Procedures

Prior to the establishment or expansion of a site, a report shall be prepared by the owner containing plans, specifications, and descriptions of the operation and maintenance of the site, including, at a minimum, the following:

- a. acceptable and unacceptable waste types, estimated annual quantities, maximum daily rate of fill, operating days per week, and hours of operation;
- b. signage posted at site entrance indicating hours and days of operation, acceptable and unacceptable wastes, operating authority, Ministry approval number, telephone number for emergencies, and additional information;
- c. site supervision and security;
- d. procedures for acceptance of incoming waste, including identification of waste requiring special handling or unacceptable waste;
- e. cover material to be used, sources of cover material, the procedures for acceptance of imported cover material, any procedures for the stockpiling of cover material prior to use, the location of any stockpiles, and the minimum number of days supply of cover material to be maintained;

- f. waste disposal equipment and procedures for waste handling, deposit, compaction, and covering;
- g. coordination and phasing of site development and operation;
- h. procedures during site development for the protection of site vegetation that is to be preserved;
- i. operation, inspection, and maintenance of any control, treatment, and disposal facilities for leachate, groundwater, surface water, and landfill gas;
- j. operation, inspection, and maintenance of any monitoring facilities for leachate, groundwater, surface water, and landfill gas;
- k. management, treatment, and disposal procedures for any collected leachate, groundwater, surface water, and landfill gas;
- l. procedures to protect any liner system from damage during waste disposal operations;
- m. procedures to protect any control facilities for leachate, groundwater, surface water, and landfill gas from damage during waste disposal operations;
- n. procedures to protect any monitoring facilities for leachate, groundwater, surface water, and landfill gas from damage during waste disposal operations;
- o. any procedures intended to alter or control the contaminating life span of the site;
- p. procedures intended to maintain or extend the service life of any engineered facility;
- q. procedures to minimize noise, odour, dust, mud tracking off site, litter, birds, vectors and vermin;
- r. a response plan for fire and other emergencies;
- s. a complaint response plan describing actions to be taken in response to complaints from the public or others concerning site activities, including the actions to be taken to identify the activity causing the complaint and minimize future occurrences;
- t. record keeping and reporting;

- u. a public communications plan;
- v. trigger criteria and procedures to implement, operate, and maintain contingency plan for landfill gas in the event the primary design of the site is inadequate;
- w. impact response criteria to initiate the impact response plan that is part of the contingency plan for leachate in the event the primary design of the site is inadequate;
- x. financial assurance provisions for a privately owned site;
- y. site closure procedures; and
- z. post-closure maintenance, monitoring, and reporting.

21. Groundwater Monitoring

A program for monitoring groundwater quality and quantity shall be carried out by the owner and shall include, at a minimum, the following:

- a. representative samples of groundwater within the site shall be:
 - i. obtained annually from groundwater monitoring facilities and be analyzed for the parameters listed in column 1 of Schedule 1; and
 - ii. obtained quarterly from groundwater monitoring facilities and be analyzed for the parameters listed in column 2 of Schedule 1;
- b. where requested by property owners or occupants, representative samples of groundwater shall be obtained from domestic wells located within 500 m of the site at a frequency of 1 sample per well per year and these groundwater samples shall be analyzed for the parameters listed in column 2 of Schedule 1;
- c. the results of analysis of a water sample collected under Subsection 21.b. shall be provided to the Director and the owner or occupant of the property with the domestic well from which the sample was obtained, within 60 days of obtaining the sample;
- d. the results of analysis of all water samples collected in the groundwater monitoring program, together with an assessment of these results shall be provided to the

Director in an annual report, and where the assessment indicates a significant increase in contaminant concentrations, within 60 days of obtaining the sample and 5 days of making the assessment;

- e. the results and assessment referred to in Subsection 21.d. shall include:
 - i. an assessment of the condition of groundwater monitoring facilities;
 - ii. an assessment of background groundwater chemistry in each of the principal hydrostratigraphic units identified in Standard 4 and sampled in the course of groundwater monitoring program;
 - iii. an assessment of the sampling results relative to the predicted results and expected impacts on groundwater at the site and adjacent to the site;
 - iv. an assessment of the need to amend the frequency or location of sampling and the analytical parameters;
 - v. an assessment of the need to amend the design or operational procedures for the site, or to implement the leachate contingency plan; and
- f. the parameters to be monitored may be amended where the owner prepares a report showing alternative parameters should be monitored, based on the type of waste to be deposited at the site.

22. Leachate Monitoring

A program for monitoring leachate quality and quantity shall be carried out by the owner and shall include, at a minimum, the following:

- a. representative samples of leachate taken from within the waste or from the primary and/or secondary leachate collection system shall be:
 - i. obtained annually and be analyzed for the parameters listed in column 1 of Schedule 1; and
 - ii. obtained quarterly and be analyzed for the parameters listed in column 2 of Schedule 1;

- b. representative measurements taken monthly of the depth of leachate mounding in the deposited waste, continuous measurements of the quantity of leachate removed from the waste fill area, and monthly estimates of the quantity of leachate accumulated in the deposited waste;
- c. the results and an assessment of the results of the leachate monitoring shall be provided to the Director in an annual report, and where the assessment indicates a significant change in the depth of leachate mounding or leachate quality, the results and assessment shall be provided within 60 days of obtaining the sample or measuring the depth and within 5 days of making the assessment;
- d. the results and assessment referred to in Subsection 22.c. shall include:
 - i. an assessment of the results of the leachate quality analyses and determinations of the depth of leachate mounding and leachate quantity relative to the predicted results;
 - ii. an assessment of the need to amend the frequency or location of sampling and analytical parameters, and the frequency, location or procedures for determining the depth of leachate mounding; and
 - iii. an assessment of the need to amend the design or operational procedures for the site, or to implement the leachate contingency plan; and
- e. the parameters to be monitored may be amended where the owner prepares a report showing alternative parameters should be monitored, based on the type of waste to be deposited at the site.

23. Surface Water Monitoring

A program for monitoring surface water quality, quantity, and biological features shall be carried out by the owner and shall include, at a minimum, the following:

- a. representative samples of surface water being discharged from the site and of any waterbody, including upstream control locations, which may be affected by leachate, stormwater runoff, or sediment from the site, shall be:

- i. obtained semi-annually and be analyzed for the parameters listed in column 3 of Schedule 1 and for other parameters of concern identified in the surface water assessment;
 - ii. obtained quarterly and be analyzed for the parameters listed in column 4 of Schedule 1;
- b. annual monitoring of biological features to assess the composition and any changes to the benthic community present in any waterbody, located downstream of storm water discharges, that may be affected by leachate, stormwater runoff, or sediment from the site;
- c. the results and assessment of the results of the surface water monitoring shall be provided to the Director in an annual report, and where the assessment indicates an increase in contaminant concentrations exceeding the natural variability exhibited by baseline and operational monitoring data, within 60 days of obtaining the sample and 5 days of making the assessment;
- d. the results and assessment referred to in Subsection 23.c. shall include:
 - i. an assessment of the sampling results relative to the predicted results and expected impacts on surface water at the site and on any waterbody that may be affected by leachate or sediment from the site;
 - ii. an assessment of the need to amend the frequency or location of sampling and analytical parameters; and
 - iii. an assessment of the need to amend the design or operational procedures for the site, or to implement the leachate contingency plan; and
- e. the parameters to be monitored may be amended where the owner prepares a report showing alternative parameters should be monitored, based on the type of waste to be deposited at the site.

24. Burning

No municipal waste shall be burned at the site unless in a portion of the site which is also approved as an incineration site.

25. Scavenging

Scavenging shall not be permitted at the site.

26. Daily and Intermediate Cover

- (1) All waste accepted for disposal at the site shall be disposed of in the waste fill area and covered by a minimum of 15 cm of daily cover soil at the end of each working day unless the owner prepares a report describing alternative cover materials or procedures.
- (2) Areas of waste fill where no additional waste will be deposited within a period of 30 days shall be covered by a minimum of 30 cm of intermediate cover soil.
- (3) Intermediate cover soils that are compacted shall be removed or scarified before placement of additional wastes overtop to promote hydraulic connection throughout the landfill.
- (4) The concentrations of contaminants in soil accepted or used at the site for use as daily or intermediate cover shall not be in excess of the concentrations for industrial land (Note: surface, potable criteria) specified in the Ministry's Clean-up Guidelines unless the owner prepares a report describing the acceptance or use of soil with an alternative quality.

27. Public Liaison Committee

- (1) Prior to the receipt of waste at the site, the owner shall offer to form a public liaison committee and hold periodic meetings during each year of operation to discuss activities carried out at the site in accordance with the following, at a minimum:
 - a. notice of the formation of a public liaison committee shall be provided to all property owners or occupants within 500 m of the site, the local municipality and any upper tier municipality in which the site is located;
 - b. the property owners or occupants shall be allowed to elect, at a minimum, a total of three representatives for the committee;
 - c. the local and upper tier municipality in which the site is located shall each be allowed a minimum of one representative for the committee;

- d. the owner shall offer to host the meetings of the liaison committee;
 - e. copies of the annual operations report shall be provided to the representatives on the public liaison committee; and
 - f. where requested by the public liaison committee, copies of any applications or reports pertaining to the site which have been submitted to the Director shall be provided to the committee.
- (2) Whenever there is not a public liaison committee in existence that has held a meeting within the previous thirteen months for an operating site, the owner shall offer to form a public liaison committee under Subsection 27(1).

28. Ownership

- (1) The owner of the site shall own the entire site, including the waste fill area and the buffer zone, but the owner is not required to own a contaminant attenuation zone.
- (2) The Director shall be notified by the owner in writing within 30 days of any change in ownership of the site.

29. Record Keeping

Daily records shall be made during the operation of the site, with a copy kept for a minimum of two years, and the records shall include, at a minimum:

- a. the type, date, and time of arrival, hauler, and quantity (by weight) of all waste received at the site;
- b. all complaints from the public received by the owner and a description of the action taken by the owner in response;
- c. the results of any tests done to determine the acceptability of waste at the site;
- d. a calculation of the total quantity (by weight) of waste received at the site for each operating day;
- e. the amount of leachate removed, treated, or discharged from the site;

- f. a record of litter collection activities and inspections of control, treatment, disposal, and monitoring facilities; and
- g. the out-of-service period of any control, treatment, disposal, and monitoring facilities, the reasons for the loss of service, and action taken to restore service.

30. Annual Operations Report

An annual report on the operation of the site during the previous calendar year shall be prepared by the owner and shall include, at a minimum:

- a. the results and an interpretive analysis of the results of all leachate, groundwater, surface water, and landfill gas monitoring, including an assessment of the need to amend the monitoring programs;
- b. an assessment of the operation and performance of all engineered facilities, the need to amend the design or operation of the site, and the adequacy of and need to implement the contingency plans;
- c. site plans showing the existing contours of the site; areas of landfilling operation during the reporting period; areas of intended operation during the next reporting period; areas of excavation during the reporting period; the progress of final cover, vegetative cover, and any intermediate cover application; previously existing site facilities; facilities installed during the reporting period; and facilities planned for installation during the next reporting period;
- d. calculations of the volume of waste, daily and intermediate cover, and final cover disposed of or applied during the reporting period and a calculation of the total volume of site capacity used during the reporting period;
- e. a calculation of the remaining capacity of the site and an estimate of the remaining site life;
- f. a summary of the quantity of leachate, groundwater, and methane gas collected, treated, and disposed of;
- g. a summary of the weekly and total tonnage of waste received at the site;

- h. a summary of the public complaints received by the owner and the responses made;
- i. a discussion of any operational problems encountered at the site and corrective action taken; and
- j. an update of the cost estimate for financial assurance.

Closure and Post-Closure Care

31. Closure and Post-Closure Care Report

A report shall be prepared by the owner at least two years before the anticipated date of closure or upon filling 90% of the total waste disposal volume, whichever comes first, and shall include:

- a. a plan showing site appearance after closure;
- b. a description of the proposed end use of the site;
- c. descriptions of the procedures for closure and post-closure care of the site, including, at a minimum, the following:
 - i. advance notification of the public of the landfill closure;
 - ii. posting of a sign at the site entrance indicating the landfill is closed and identifying any alternative waste disposal arrangements;
 - iii. completion, inspection, and maintenance of the final cover and landscaping;
 - iv. site security;
 - v. removal of unnecessary structures, buildings, and facilities;
 - vi. final construction of any control, treatment, disposal, and monitoring facilities for leachate, groundwater, surface water, and landfill gas;
 - vii. operation, inspection, and maintenance of the control, treatment, disposal, and monitoring facilities for leachate, groundwater, surface water, and landfill gas;

- viii. record keeping and reporting;
 - ix. complaint contact and response;
 - x. trigger criteria and procedures to implement, operate, and maintain the contingency plan for landfill gas in the event the primary design of the site is inadequate; and
 - xi. impact response criteria to initiate the impact response plan that is part of the contingency plan for leachate in the event the primary design of the site is inadequate;
- d. an updated estimate of the contaminating life span, based on the results of the monitoring to date; and
 - e. financial assurance provisions, in the case of privately-owned sites.

32. Annual Post-Closure Report

An annual report on the post-closure care of the site during the previous calendar year shall be prepared by the owner and shall include, at a minimum:

- a. the results and an interpretive analysis of the results of all leachate, groundwater, surface water, and landfill gas monitoring, including an assessment of the need to amend the monitoring programs;
- b. an assessment of the adequacy of and need to implement the contingency plans;
- c. a discussion of any maintenance or operational problems encountered and the corrective action taken concerning the final cover and any control, treatment, disposal, and monitoring facilities for leachate, groundwater, surface water, and landfill gas;
- d. a summary of the quantity of leachate, groundwater, and methane gas collected, treated, and disposed of;
- e. an assessment of the need to continue control, treatment, disposal, or monitoring of leachate, groundwater, surface water, or landfill gas;
- f. an update of the cost estimate for financial assurance; and

- f. a summary of the public complaints received by the owner and the responses made.

Financial Assurance

33. Financial Assurance - Closure & Post-Closure Care

- (1) Financial assurance for the closure and post closure care of the site shall be provided to the Director by the owner of a privately owned site in accordance with the following:
- a. the financial assurance shall be in an amount which covers the estimated costs for the following:
 - i. the planned closure of the largest area of the site that will require final cover at any one time during the operation of the site including the costs for obtaining and constructing the final cover and for establishing the vegetative cover;
 - ii. maintenance of the final cover and landscaping; and
 - iii. the construction, operation, maintenance and replacement of any control, monitoring, treatment or disposal facilities for leachate, groundwater, surface water and landfill gas, including any analytical or reporting costs, which is required or expected to be required for the site but which has not been constructed or carried out;
 - b. the financial assurance shall be a cash deposit in the Consolidated Revenue Fund of the Province of Ontario or an alternate form of funding acceptable to the Director;
 - c. the amount of financial assurance shall be sufficient to cover the costs estimated for the contaminating life span of the site with respect to the particular facility or activity;
 - d. a minimum of 10 percent of the financial assurance shall be provided within two years of waste being deposited at the new or expanded site, with additional amounts provided annually thereafter;

- e. the amount of financial assurance is to be accumulated at a rate at least in proportion to the filling of the site but with 100 percent to be in place five years before the anticipated date of closure or upon filling 80 percent of the total waste disposal volume, whichever comes first;
 - f. the estimation of costs and the amount of financial assurance provided shall be updated annually or as otherwise required by the Director; and
 - g. the financial assurance shall remain in place until the owner prepares a report showing that the financial assurance is no longer required.
- (2) Financial assurance for the closure and post closure care of the site may be used by the Director if necessary to cover the costs of any unplanned closure of the site prior to the site being filled to the approved contours.
 - (3) Any amount of financial assurance used by the Director pursuant to Subsection 33(2) shall be replaced by the owner of the site within 3 months of being notified by the Director.

34. Financial Assurance - Contingency Plan

- (1) Financial assurance for the construction, operation, maintenance and replacement of the contingency plan for the site shall be provided to the Director by the owner of a privately owned site in accordance with the following:
 - a. the amount of financial assurance shall be the future value of the 1996 base year unit amount of fifty cents per tonne of waste multiplied by the expected total waste tonnage capacity of the site, where:
 - i. the future value is determined by applying an appropriate inflationary cost index to the total 1996 base year value, and
 - ii. the future value is the value in the year occurring five years before the anticipated date of closure, or the anticipated date of filling 80 percent of the total waste disposal volume, whichever comes first;

- b. the financial assurance shall be a cash deposit in the Consolidated Revenue Fund of the Province of Ontario or an alternate form of funding acceptable to the Director;
 - c. a minimum of 10 percent of the future value amount shall be provided within two years of waste being deposited at the new or expanded site, with additional amounts provided annually thereafter;
 - d. the amount of financial assurance is to be accumulated at a rate at least in proportion to the filling of the site but with 100 percent to be in place five years before the anticipated date of closure or upon filling 80 percent of the total waste disposal volume, whichever comes first;
 - e. the financial assurance shall remain in place until the owner prepares a report showing that the financial assurance is no longer required.
- (2) Financial assurance for the contingency plan for the site may be used by the Director if necessary to cover the costs of any unplanned closure, or the closure and post closure care of the site.
 - (3) Any amount of financial assurance used by the Director pursuant to Subsection 34(2) shall be replaced by the owner of the site within 3 months of being notified by the Director.
 - (4) The requirement for site specific financial assurance under Subsections 34(1), 34(2) and 34(3) do not apply where financial assurance for the contingency plan is provided by a group financial assurance plan acceptable to the Director.

Definitions

For purposes of this regulation:

"Airport Reference Point" means the designated point or points on an airport normally located at or near the geometric centre of the runway complex that establishes the locus of the radius or radii of the outer surface (as defined in a Zoning Regulation).

"Contaminant Attenuation Zone" means an area of land adjacent to the landfilling site for which the owner of the landfilling site has obtained the written agreement of the owner of the off-site property to allow leachate from the site to increase the concentration of any contaminant in the groundwater of the off-site area to exceed the maximum allowable concentration defined in accordance with the Ministry's Reasonable Use Guideline (MOEE, 1994) and for which the written agreement has been registered on title.

"Contaminating Life Span" means the period of time during which the landfill will produce contaminants at concentrations that could have unacceptable impact if they were discharged into the surrounding environment. This may be interpreted to be the time period from the start of landfill operations to the point in time after which active leachate removal could cease and contaminants passively released to the groundwater environment would meet Reasonable Use Guideline criteria at the point of compliance.

"Director" means one or more of the persons who from time to time are so designated for the purpose of Section 39 of the Environmental Protection Act.

"Dynamic Beach" means areas of inherently unstable accumulations of shoreline sediments along the Great Lakes - St. Lawrence River System and large inland lakes. The dynamic beach hazard limit includes the flooding hazard limit plus a dynamic beach allowance.

"Engineered Facility" means any structure, equipment, apparatus, mechanism, device or works that is constructed or used as part of the design and operation of a landfilling site, whether the site is accepting waste or not.

"Erosion Hazards" means the loss of land, due to human or natural processes, that poses a threat to life and property. The erosion hazard limit is determined using the 100 year erosion rate (the average annual rate of recession extended

over a hundred year time span), an allowance for slope stability, and/or an erosion allowance (e.g., toe and erosion protection).

"Flood Plain" (for river and stream corridors) means the area, usually low lands adjoining a watercourse, which has been or may be subject to flooding hazards.

"Flooding Hazards" means the inundation, under the conditions specified below, of areas adjacent to a shoreline or a river or stream corridor and not ordinarily covered by water:

- a) Along the shorelines of the Great Lakes - St. Lawrence River System and large inland lakes, the flooding hazard limit is based on the 100 year flood level plus an allowance for wave uprush and other water related hazards.
- b) Along river and stream systems, the flooding hazard limit is the greater of:
 - 1. the flood resulting from the rainfall actually experienced during a major storm such as the Hurricane Hazel storm (1954) or the Timmins storm (1961), transposed over a specific watershed and combined with the local conditions, where evidence suggests that the storm event could have potentially occurred over watersheds in the general area;
 - 2. the one hundred year flood; or
 - 3. a flood which is greater than 1. or 2. which was actually experienced in a particular watershed or portion thereof as a result of ice jams and which has been approved as the standard for that specific area by the Minister of Natural Resources;

except where the use of the one hundred year flood or actually experienced event as the standard for a specific watershed has been approved by the Minister of Natural Resources (where the past history of flooding supports the lowering of the standard).

"Floodway (for river and stream systems)" means the portion of the flood plain where development (other than uses which by their nature must be located within the floodway, flood and/or erosion control works, or where appropriate, minor additions or passive, non-structural uses which do not

affect flood flows) and site alteration would cause a danger to public health and safety or property damage.

"Great Lakes - St. Lawrence River System" means the major water system consisting of Lakes Superior, Huron, St. Clair, Erie and Ontario and their connecting channels, and the St. Lawrence River within the boundaries of the Province of Ontario.

"Hazardous Lands" means property or lands that could be unsafe for development due to naturally occurring processes. Along the shorelines of the Great Lakes - St. Lawrence River System, this means the land, including that covered by water, between the international boundary, where applicable, and the furthest landward limit of the flooding, erosion or dynamic beach hazard limits. Along the shorelines of large inland lakes, this means the land, including that covered by water between a defined offshore distance or depth and the furthest landward limit of the flooding, erosion or dynamic beach hazard limits. Along rivers and stream systems, this means the land, including that covered by water, to the furthest landward limit of the flooding or erosion hazard limits.

"Hazardous Sites" means property or lands that could be unsafe for development and site alteration due to naturally occurring hazards. These may include unstable soils (sensitive marine clays [leda], organic soils) or unstable bedrock (karst topography).

"Large Inland Lakes" means those waterbodies having a surface area of equal to or greater than 100 square kilometres where there is not a measurable or predictable response to a single runoff event.

"Natural Heritage Features and Areas" means features and areas, such as significant wetlands, fish habitat, significant woodlands south and east of the Canadian Shield, significant valleylands south and east of the Canadian Shield, significant portions of the habitat of endangered and threatened species, significant wildlife habitat, and significant areas of natural and scientific interest, which are important for their environmental and social values as a legacy of the natural landscapes of an area.

"One Hundred Year Flood (for river and stream systems)" means that flood, based on an analysis of precipitation, snow melt, or a combination thereof, having a return period of 100 years on average, or having a 1% chance of occurring or being exceeded in any given year.

"One Hundred Year Flood Level" means:

- for the shorelines of the Great Lakes, the peak instantaneous stillwater level, resulting from combinations of mean monthly lake levels and wind setups, which has a 1% chance of being equalled or exceeded in any given year.
- In the connecting channels (St. Mary's, St. Clair, Detroit, Niagara and St. Lawrence Rivers), the peak instantaneous stillwater level which has a 1% chance of being equalled or exceeded in any given year.
- For large inland lakes, lake levels with wind setups that have a 1% chance of being equalled or exceeded in any given year, except that, where sufficient water level records do not exist, the one hundred year flood level is based on the highest known water level and wind setups.

"Primary Leachate Collection System" means the uppermost leachate collection system in direct contact with the waste.

"Public Airport" means an airport certified by Transport Canada which may be used by the general public without obtaining the prior permission of the operating authority for the airport.

"River and Stream Systems" means all watercourses, rivers, streams, and small inland lakes or waterbodies that have a measurable or predictable response to a single runoff event.

"Secondary Leachate Collection System" means the leachate collection system located below the primary leachate collection system and liner.

"Service Life" means the period of time during which an engineered facility, which is properly maintained, will function in accordance with the performance specifications for its design.

"Site" means the landfilling site, including the waste fill area and the adjacent buffer zone, but does not include a contaminant attenuation zone.

"Site Closure" means the time when the site has been determined to have reached final waste contours or waste is no longer to be deposited at the site.

"Special Policy Area" means an area within a community that has historically existed in the flood plain and where site specific policies, approved by the Ministers of Natural Resources and Municipal Affairs and Housing, are intended to address the significant social and economic hardships to the community that would result from strict adherence to provincial policies concerning development.

"Total Waste Disposal Volume" means the total volume of the waste fill area between the bottom of the final cover and the top of the base of the site, or the top of any engineered facilities located on the base of the site, in which waste and any daily or intermediate cover is to be deposited.

"Waste Fill Area" means the area of the site in which waste is disposed of by landfilling.

Schedule 1
Groundwater, Leachate and Surface Water Monitoring Parameters

Parameter Group	Parameter			
	Column 1	Column 2	Column 3	Column 4
	Comprehensive List for Groundwater and Leachate	Indicator List for Groundwater and Leachate	Comprehensive List for Surface Water	Indicator List for Surface Water
Inorganics				
	Alkalinity	Alkalinity	Alkalinity	Alkalinity
	Ammonia		Ammonia	Ammonia
	Arsenic		Arsenic	
	Barium		Barium	
	Boron		Boron	
	Cadmium	Cadmium	Cadmium	
	Calcium	Calcium		
	Chloride	Chloride	Chloride	Chloride
	Chromium		Chromium	
	Conductivity	Conductivity	Conductivity	Conductivity
	Copper		Copper	
	Iron	Iron	Iron	
	Lead	Lead	Lead	
	Magnesium	Magnesium		
	Manganese			
	Mercury		Mercury	
	Nitrate	Nitrate	Nitrate	Nitrate

Parameter Group	Parameter			
	Column 1	Column 2	Column 3	Column 4
	Comprehensive List for Groundwater and Leachate	Indicator List for Groundwater and Leachate	Comprehensive List for Surface Water	Indicator List for Surface Water
	Nitrite		Nitrite	Nitrite
	Total Kjeldahl Nitrogen		Total Kjeldahl Nitrogen	Total Kjeldahl Nitrogen
	pH	pH	pH	pH
	Total Phosphorus		Total Phosphorus	Total Phosphorus
	Potassium	Potassium		
	Sodium	Sodium		
	Suspended Solids	Suspended Solids	Suspended Solids	Suspended Solids
	Total Dissolved Solids	Total Dissolved Solids	Total Dissolved Solids	Total Dissolved Solids
	Sulphate	Sulphate	Sulphate	Sulphate
	Zinc		Zinc	
Volatile Organics				
	Benzene			
	1,4 Dichlorobenzene			
	Dichloromethane		Dichloromethane	
	Toluene		Toluene	
	Vinyl Chloride			

Parameter Group	Parameter			
	Column 1	Column 2	Column 3	Column 4
	Comprehensive List for Groundwater and Leachate	Indicator List for Groundwater and Leachate	Comprehensive List for Surface Water	Indicator List for Surface Water
Other Organics				
			Biochemical Oxygen Demand (BOD ₅)	Biochemical Oxygen Demand (BOD ₅)
	Chemical Oxygen Demand	Chemical Oxygen Demand	Chemical Oxygen Demand	Chemical Oxygen Demand
	Dissolved Organic Carbon	Dissolved Organic Carbon		
	Phenol		Phenol	Phenol
Field Parameters				
			Temperature	Temperature
	pH	pH	pH	pH
	Conductivity	Conductivity	Conductivity	Conductivity
			Dissolved Oxygen	Dissolved Oxygen
			Flow	Flow



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